VISHAY INTERTECHNOLOGY, INC.

INTERACTIVE
data book

STRAIN GAGE INSTRUMENTATION
VISHAY MICRO-MEASUREMENTS

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DATA BOOK

STRAIN GAGE INSTRUMENTATION

VISHAY MICRO-MEASUREMENTS

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Strain Gage Instrumentation

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Considerations for Instrument Selection

STRAIN INDICATORS

Basic instrumentation requirements call for stability, accuracy and high resolution when making measurements under static loading conditions, and particularly where measurements are to be taken over long periods of time. Vishay Micro-Measurements offers two strain indicator models meeting these demanding criteria.

The Model P3 Strain Indicator and Recorder is a portable, battery-operated instrument capable of simultaneously accepting four inputs from quarter-, half-, and full-bridge strain-gage circuits, including strain-gage-based transducers. A highly stable measurement circuit, regulated bridge excitation supply, and precisely settable gage factor enable measurements of ±0.1% accuracy and 1 microstrain resolution. Data, recorded at a user-selectable rate of up to 1 reading per channel per second, is stored on a removable multimedia card and is transferred by USB to a host computer for subsequent storage, reduction and presentation with third-party software. The P3 can also be configured and operated directly from your PC with a separate software application included with each instrument.

The Model 3800 Wide Range Strain Indicator is a versatile, high-precision laboratory-type instrument designed for use with strain gages and strain gage based transducers. Principal features of the Model 3800 are wide-range control of gage factor; excitation precisely settable over 1 – 15 volt range; and wide balance range with no bridge loading effect. With these extended operating capabilities, the Model 3800 can be used for the most demanding measurement tasks which are not possible with conventional strain measuring instruments and general-purpose transducer indicators. Resolutions achievable with the Model 3800 are 0.10 microstrain when used as a strain indicator, and 0.10μV/V when used as a transducer indicator (0.025μV/V with suppressed zero).

SIGNAL CONDITIONING AMPLIFIERS

When signals are produced by dynamically applied loads at frequencies above 0.1Hz, or are transients, measuring instrumentation requires adequate frequency response, and a wide amplifier gain range for output to the appropriate recording or display device. Such an instrument consists of an amplifier and signal conditioner with a built-in or shared power supply. Individual units are normally required for each channel when simultaneous recording or multiple channels are needed. With the output sent to a suitable display device, signal conditioning amplifiers can be used for making long-term measurements under static loading conditions, when maximum stability and accuracy are not primary considerations.

The A2, 2200, and 2300 Systems accept low-level signals, and condition and amplify them into high-level outputs suitable for multiple channel, simultaneous, dynamic recording. All of these systems can be used in conjunction with a variety of recording devices.

DIGITAL DATA SYSTEMS

Depending on their design, digital data systems can be used for measurement of static, dynamic, or both kinds of signals. Vishay Micro-Measurements offers three digital data systems, each controlled with StrainSmart® software.

System 5000 is used for static signals with a scanning rate of 1ms per scan for up to 1200 channels. Typical usage is fifty complete scans per second. Input channels in each single scanner are scanned sequentially at 0.04-ms intervals and stored in random access memory within a 1-ms window. Multiple scanners acquire data concurrently.

System 6000 is used for dynamic signals with scanning rates up to 10,000 samples per second per channel and up to 1200 channels. System 6000 provides individual analog-to-digital conversion on each channel and simultaneous sampling data acquisition for all channels. Selectable, digital Finite Impulse Response (FIR) low-pass filtering is incorporated into each instrumentation channel to meet a variety of testing requirements. Custom filters are also available.

System 7000 is a high performance dynamic data acquisition instrument with measurement accuracy of ±0.05% of full scale. Each sensor card employs a 24-bit analog to digital converter enabling 0.5 microstrain resolution. Scan rates up to 2048 samples per second are available for simultaneous reading of all sensor inputs. A combination of analog and flexible Finite Impulse Response (FIR) filters are available to provide adequate anti-alias filtering at all scanning rates. Electronically selectable bridge completion resistors allow the user to choose between 120-, 350-, and 1000-ohm strain gages through software selection. System 7000 is capable of self-calibration with a removable calibration reference.

Instrument Selection Guide

STRAIN INDICATORS						
Instrument	**Display**	**Operation**	**Bridge Excitation**	**Input Power**	**Multi-Channel**	**Remarks**
P3	Digital	Manual, Direct-Reading	1.5Vdc	Battery, USB, or AC Adapter	Automatic	Portable, 4-channel 0.1% Accuracy
3800	Digital	Manual, Direct-Reading	DC Step Selectable 1.0-15.0V	AC	Manual	Wide-Range High-Precision Laboratory Strain Indicator

SIGNAL CONDITIONING AMPLIFIERS						
Instrument	**Frequency Response (1)**	**Output (±)**	**Amplifier Gain**	**Bridge Excitation**	**Input Power**	**Remarks**
A2	DC 110kHz -3dB	10V	125-2500	DC 0.0-10V	DC (AC optional)	General-Purpose Signal Conditioner with Digital Control
2200	DC 50kHz -0.5dB DC 100kHz -3dB	10 V at 10mA and 1Vms at 10mA	Continuously Variable 1-3300	DC: 0.5-15V or 0.5-15mA	AC	High Performance, For Demanding Environments
2300	DC 60kHz -0.5dB DC 145kHz -3dB	10V	Continuously Variable 1-11 000	DC 0.2-7V Variable	AC	High Frequency Response Multi-Feature Signal Conditioner

(1) Typical - see specific product bulletin and/or instruction manual for detailed performance specifications.

DIGITAL DATA SYSTEMS						
Instrument	**Operating Mode (2)**	**Channels**	**Scanning Rate**	**Bridge Excitation (3)**	**Input Power**	**Remarks**
5000 (5100)	Stationary, Online	5-1200 (in sets of 5)	1-50 Samples/ Sec/Channel	0-10Vdc Programmable	AC	5-Hz Low-Pass Filter
6000 (6100)	Stationary, Online	1-1200	10-10,000 Samples/ Sec/Channel	0-10Vdc Programmable	AC	Programmable Digital Filters to 4kHz
6000 (6200)	Remote, Stand-alone	1-1200	10-10,000 Samples/ Sec/Channel	0-10Vdc Programmable	DC (AC Optional)	Programmable Digital Filters to 4kHz
7000	Stationary, Online	Unlimited (in sets of 8)	10-2048 Samples/ Sec/Channel	0-10Vdc Programmable	AC	Programmable Digital Filters to 800Hz

(2) All systems can be operated with StrainSmart software for data acquisition, storage, reduction, and presentation, or with other third-party software.

(3) Strain gage cards only.

Considerations for instrument selection are provided on the facing page for all general-purpose instrumentation and data systems produced by Vishay Micro-Measurements. Additionally, our Applications Engineering staff is always available to assist you in selecting the right instrument for your specific applications.

micro-measurements@vishay.com

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3800 9

Strain Indicators

Strain Indicator and Recorder

FEATURES

- Four input channels
- Direct reading LCD display
- On-board data storage
- 0 to 2.5Vdc analog output
- Quarter, half and full bridge circuits
- Built-in bridge completion
- 120-, 350- and 1000-ohm dummy gages
- Automatic zero-balancing and calibration
- Intuitive, menu-driven operations
- USB data link
- Operation from keypad or PC
- Portable, lightweight and rugged
- Battery, USB or line-voltage power

DESCRIPTION

The Model P3 Strain Indicator and Recorder is a portable, battery-operated instrument capable of simultaneously accepting four inputs from quarter-, half-, and full-bridge strain-gage circuits, including strain-gage-based transducers. Water-resistant grommets in the hinged cover allow the lid to be closed with leadwires attached. Designed for use in a wide variety of physical test and measurement applications, the P3 functions as bridge amplifier, static strain indicator, and digital data logger.

The Model P3 Strain Indicator and Recorder, utilizing a large LCD display for readout of setup information and acquired data, incorporates many unique operating features that make it the most advanced instrument of its kind. An extensive, easy-to-use menu-driven user interface operates through a front-panel keypad to readily configure the P3 to meet your particular measurement requirements. Selections include active input and output channels, bridge configuration, measurement units, bridge balance, calibration method, and recording options, among others.

Data, recorded at a user-selectable rate of up to 1 reading per channel per second, is stored on a removable multimedia card and is transferred by USB to a host computer for subsequent storage, reduction and presentation with third-party software.

The P3 can also be configured and operated directly from your PC with a separate software application included with each instrument. Additionally, a full set of ActiveX components is provided for creating custom applications in any language supporting ActiveX.

A highly stable measurement circuit, regulated bridge excitation supply, and precisely settable gage factor enable measurements of ±0.1% accuracy and 1 microstrain resolution. Bridge completion resistors of 120, 350 and 1000 ohms are built in for quarter-bridge operation. Also, input connections and switches are provided for remote shunt calibration of transducers and full-bridge circuits.

The P3 operates from an internal battery pack of two readily available D cells. Battery life depends upon mode of operation but ranges up to 600 hours of continuous use for a single channel. It can also be powered by connection to an external battery or power supply, a USB port on a PC or with an optional external line-voltage adapter.

Strain Indicator and Recorder

HARDWARE SPECIFICATIONS

All specifications nominal or typical at + 23°C unless noted.

Inputs:
Eccentric-lever-release terminal blocks accept up to four independent bridge inputs. Accommodates 16-28 AWG (1.3 to 0.35mm dia.)

Bridge Configurations:
Quarter-, half-, and full-bridge circuits. Internal bridge completion provided for 120Ω, 350Ω and 1000Ω quarter bridges, 60 to 2000Ω half or full bridge.

Display:
Full dot-matrix structure with 128 dots x 64 dots FSTN positive, gray transflective LCD with backlight. Display update is twice a second.

Data Conversion:
High-resolution sigma-delta converter. 60Hz or 50Hz noise rejection. User selectable.

Basic Range:
±31,000 microstrain (±1 microstrain resolution) at Gage Factor = 2.000.

Accuracy:
±0.1% of reading ±3 counts. (Normal mode operation at Gage Factor = 2.000)

Gage Factor Settings:
Range 0.500 to 9.900.

Balance:
Single key operation to initiate automatic software balance.

Bridge Excitation:
1.5Vdc nominal. Readings are fully ratiometric, and not degraded by variation in excitation voltage.

Communication Interface:
Universal Serial Bus with type B connector. Used for transferring stored data and firmware.

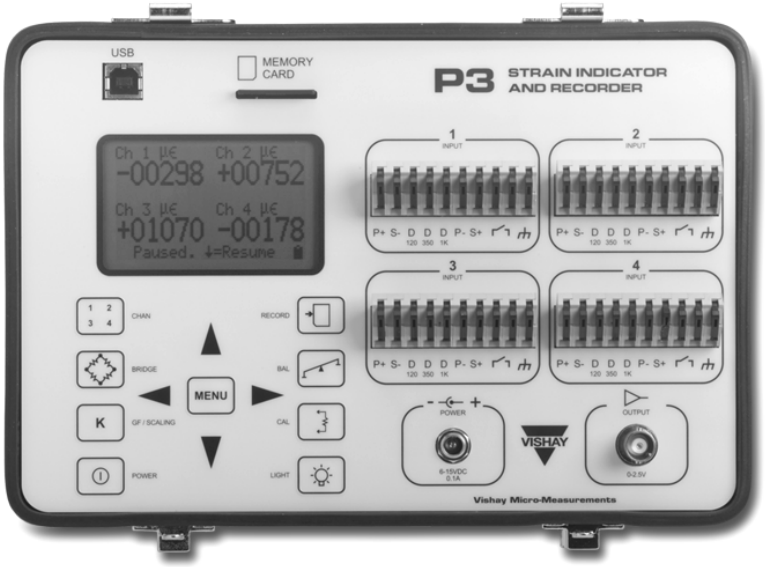
Data Storage:
Media: Removable Multimedia Card (16Mb supplied) Data Recording Rate: 1 reading per second maximum

Calibration:
Shunt calibration across each dummy resistor to simulate 5000 microstrain (± 0.1%). Remote calibration supported via accessible switch contacts at input terminal block.

Analog Output:
BNC connector. 0 to 2.5V maximum output. Device impedance of 2000Ω or greater. 480 samples/second DAC output update rate.

Power:
Internal battery pack using two “D” cells. Battery life up to 600 hours (single channel, normal mode.) Can also be powered from USB or by external battery or other power source of 6 to 15Vdc. AC adapter optional.

Operational Environment:
Temperature 0 to + 50°C. Humidity up to 90% RH, noncondensing.



Strain Indicator and Recorder

FIRMWARE FEATURES

Display Update Rate:
- 2 readings per second.

Recording Rates:
- Up to 64 data files.
- Automatic recording:
  – 1 reading every 1 to 3600 seconds.
  – individually selectable per channel.
- Manual Recording.
- Automatic date/time stamping.

Scaling:
- Automatic scaling for microstrain, based upon gage factor, with nonlinearity correction based upon bridge type.
- Automatic calculation of mV/V.
- Linear scaling for other engineering units.

Units:
- με
- mV/V
- psi
- ksi
- GPa
- MPa
- Pa
- g
- lbf
- lb
- Kg
- in
- mm
- mil
- rpm
- m
- s
- A
- N
- V
- Ohms
- hp
- deg
- rad
- oz
- mV
- m/s^2
- ton

Bridge Types:
- Quarter bridge.
- Half bridge, adjacent arms, equal and opposite strains.
- Half bridge opposite arms equal strains.
- Shear bridge, 2 active arms.
- Poisson half bridge.
- Full bridge 4 fully active arms.
- Shear bridge, 4 active arms.
- Full bridge, Poisson gages in opposite arms.
- Full bridge, Poisson gages in adjacent arms.
- Undefined full bridge.
- Undefined half bridge/quarter bridge.

Bridge Balance:
- Automatic
- Manual offset adjust
- Disabled (Raw offset)

Backlight Control:
- Programmable on time while in run mode:
  – 5, 15 or 60 seconds.
  – Manual off/on.
- If illuminated, backlight will remain illuminated while operating menus.

Software Adjustable Contrast

Operating Modes:
- Normal mode.
- Analog output (any one of four channels.)

Data Link:
- USB interface
- Windows-based P3 utility software provided for creating Excel and ASCII files from data stored on MMC.
- No device driver required (treated as an HID device).

Real-time Clock

System Calibration/Verification:
- Requires Model 1550A Strain Indicator calibrator or other compatible calibrator.
- Calibration date stored in flash.

Firmware Upgradeable

Wide Range Strain Indicator

A versatile high-performance laboratory-type instrument featuring wide-range operating controls for handling the most critical strain measuring tasks.

FEATURES

- 4-1/2 Digit LED Display
- ANSI/SEM Color-coded bridge connection terminals
- Analog output
- Transducer connector with remote sense
- Direct reading of strain, pressure, torque, load, and other engineering variables
- Convenient color-coded push-button controls
- Gage factor range from 0.0500 to 50.00 displayed on LED readout (to four significant digits)
- Bridge excitation range from 1.000 to 15.000Vdc
- Extremely wide balance range. Balance by voltage injection
- Quarter-, half-, and full-bridge circuits
- Built-in 120/1000Ω and 350Ω bridge completion
- Separate bridge excitation on/off control

DESCRIPTION

EXCEPTIONAL RANGE • RESOLUTION • VERSATILITY NEVER BEFORE ACHIEVED IN A LABORATORY INSTRUMENT

The Model 3800 Wide Range Strain Indicator is a versatile, high-precision laboratory-type instrument designed for use with strain gages and strain gage based transducers.

Principal features of the Model 3800 are wide-range control of gage factor; excitation precisely settable over 1 - 15 volt range; and wide balance range with no bridge loading effect.

With these extended operating capabilities, the Model 3800 can be used for the most demanding measurement tasks which are not possible with conventional strain measuring instruments and general-purpose transducer indicators. Resolutions achievable with the Model 3800 are 0.10με when used as a strain indicator, and 0.10μV/V when used as a transducer indicator (0.025μV/V with suppressed zero).

In addition to the wide-range features, the Model 3800 incorporates simplified operating controls that minimize set-up time, and promote measurement accuracy. The operator follows a logical sequence of steps to configure the instrument for the desired measurement. Color-coded interlocked push-button controls minimize operator errors, and make the operating mode instantly recognizable.

Gage factor on the Model 3800 is settable by front-panel controls over a range of 0.0500 to 50.00, and is displayed by the LED readout when in the SET position. The instrument allows full range display (±19 999 counts) over the complete gage factor range.

Excitation voltage is precisely settable over a range of 1 - 15 volts in 1-volt increments by a front-panel thumbwheel switch. The output display automatically tracks the excitation setting so that gage factor does not vary with bridge voltage.

The balance system in the Model 3800 has four ranges which are selected by the BALANCE RANGE push buttons. Each range is further divided into four sub ranges by the COARSE balance switch. The FINE balance control provides an additional adjustment range that overlaps the COARSE balance switch positions. This unique system provides a total of 32 overlapping ranges for achieving precise balance settings and resolution. All balance voltages are electronically injected into the input amplifier to eliminate bridge loading errors and preserve full measurement range.

The instrument will accept full-, half-, or quarter-bridge strain gage inputs; and all required bridge completion components for 120, 350, and 1000Ω gages are built in. Shunt-calibration resistors across the internal dummies are provided on the rear panel. Two remote calibration resistors, also mounted on the rear panel, are actuated by the front-panel calibration button.

Virtually all strain gage based transducers can be used with the Model 3800 via the rear-panel transducer connector. This connector provides precision remote sense capability, as well as access to the remote calibration resistors. Full-scale resolutions of 0.10μV/V are routinely possible. By using the wide-range balance controls to suppress zero, resolutions to 0.025μV/V can be achieved.

In addition to the digital LED display, the Model 3800 provides an analog output available at the rear panel. A separate analog level control totally independent of the digital display is also provided.

The Model 3800 Wide Range Strain Indicator is an exceptional, high-resolution instrument that will make a valuable contribution to any experimental stress analysis or transducer development laboratory.

Wide Range Strain Indicator

SPECIFICATIONS

Range and Display:
±19 999 counts direct-reading LED display.

Resolution:
1με at any gage factor from 0.0500 to 50.00.
0.10μV/V as a transducer indicator.

Linearity:
±0.01% of full scale.

Balance Range:
Coarse balance: ±2.5% to ±100% of full scale per step, in 32 total steps.

Fine balance: ±1.25% to ±50% of full scale; overlaps each coarse balance step.

Balance Method:
Electronically injected counter-emf.

Gage Factor:
Range: 0.0500 to 50.00; displayed by LED readout when in the SET position.

Resolution:
0.0001 from GF of 0.0500 to 0.5000
0.001 from GF of 0.500 to 5.000
0.01 from GF of 5.00 to 50.00

Linearity: ±0.05% of full scale.

Accuracy: ±1 least significant digit.

Excitation Voltage:
1.000 to 15.000Vdc±1mV±0.02%. Settable in 1V increments by front-panel thumbwheel switch.

Temperature stability: ±0.01%/°C.

Amplifier:
Temperature effect on zero: ±1.0μV/°C RTI† max.; ±0.50μV/°C RTI† typical.

Temperature effect on span: ±0.005%/°C max.

Warm-up drift: less than ±3μV RTI† from turn-on to 5 minutes.

Random drift at constant ambient temperature: less than ±1μV RTI†.

Common-mode rejection: greater than 100dB at 50-60Hz.

Common-mode voltage: ±8V max.

Input impedance: greater than 100MΩ differential and common mode.

Input circuits: quarter-, half-, and full-bridge circuits. Internal bridge completion provided for 120/1000Ω and 350Ω quarter bridges; 60 to 2000Ω half or full bridge.

Calibration: shunt calibration resistors are provided across internal 120Ω and 350Ω dummy gages to simulate 5000με±0.05%. Calibration resistors are located on the rear of instrument and may be changed to suit specific requirements. Contact closures are provided for two rear-panel-mounted resistors to facilitate any calibration configuration. Typical use is double-shunt calibration of transducers.

Analog Output:
Linear output: ±10.00V max; adjustable over 11:1 range by a ten-turn potentiometer mounted on the rear panel.

Output load: 2kΩ min.

Bandwidth: GF >0.500, dc to 4.5kHz (–3 dB nominal).
GF <0.500, dc to 2.0kHz (–3 dB nominal).

Output noise: less than 2.5μV peak to peak 0.10 to 10Hz, RTI†. Less than 2μV rms dc to 5kHz, RTI†, plus 0.005% of full scale, RTO (referred to output).

Remote Sense:
Remote sense connections provided at transducer connector.
Remote sense error: less than 0.0005%/Ω of lead resistance.
Maximum lead resistance 40Ω or less.

Power:
115/230Vac, 50-60Hz, less than 10 volt-amperes.

Size and Weight:
6.5 H x 11.0 W x 12.5 D in (165 x 280 x 318mm).
10.2lb (4.6kg).

†Referred to input
All specifications are nominal or typical at +23°C unless noted.

Companion instruments for use with the Model 3800

Model V/E-40 Decade Resistor Strain Gage Simulator, and Model 1550A Strain Indicator Calibrator — with these specialized instruments, the capabilities and sensitivity of the Model 3800 can be further extended by making critical measurements through precise strain simulation.

A2 System 12
2200 System 16
2300 System 22

Signal Conditioning Amplifiers

Signal Conditioning Amplifier System

FEATURES

- Strain gage, transducer, and thermocouple inputs
- Frequency response to 110kHz
- Analog output of ±10VDC
- Operation with 12 to 15VDC and 120/240Vac power
- Scalable from 8 to 128 channels in high-density enclosures
- Digital control from both front panel and PC over Ethernet
- Remote channel-by-channel monitoring of signals by Ethernet

DESCRIPTION

The A2 is an analog signal conditioner and amplifier system for strain gages, strain-gage-based transducers, thermocouples and various other sensors with high-level signals. Scalable in multiples of eight channels to a maximum of 128 for each system, the A2 features digital control of the system instrumentation and monitoring of the analog outputs, both locally on the control panel and remotely by Ethernet from a PC. The Model A2 is an embedded web server. All system, card, and channel settings are accessible using simple HTTP (hypertext transfer protocol) commands or by using the graphical user interface provided by the system. Ordinary web browsers, such as Internet Explorer, can be used to control the system.

The A2 is specially designed to function as the front-end for DAQ's and recorders accepting high-level analog signals.

Instrumentation hardware, available as individual eight-channel cards for strain gage, thermocouples, and high-level signals, features high stability with temperature and time. Strain-gage instrumentation accepts full-, half-, and quarter-bridge circuits and has built-in bridge completion resistors for 120-, 350- and 1000-ohm quarter bridges. Amplifiers gain; bridge excitation and balance; shunt calibration; and signal filtering are digitally controlled. Instrument design enables sensors to remain connected when cards are removed from the system for bridge configuration.

SPECIFICATIONS

General
All specifications are nominal or typical at +23°C unless noted. Performance may be degraded in the presence of high-level electromagnetic fields.

System Configuration
Each system consists of a Model A2-MC-8 Controller and at least one 8-channel instrumentation card. Stackable expansion cabinets are added when two or more instrumentation cards are used.

Physical Dimensions:
Eight Channel Enclosure with Controller:
17" W x 12" D x 8.5" H [43.2cm W x 30.5cm D x 21.6cm H]
40 Channel Enclosure with Controller:
17" W x 12" D x 17.5" H [43.2cm W x 30.5cm D x 44.6cm H]
72 Channel Enclosure with Controller:
17" W x 12" D x 26.5" H [43.2cm W x 30.5cm D x 67.3cm H]
104 Channel Enclosure with Controller:
17" W x 12" D x 35.5" H [43.2cm W x 30.5cm D x 90.2cm H]
128 Channel Enclosure with Controller:
17" W x 12" D x 44.5" H [43.2cm W x 30.5cm D x 113.0cm H].

Input Power:
115 or 230VAC with optional external "line lump" power supply (15VDC output). Will also work from a 12V battery with reduced specifications.

Controller with Model A2-EC Expansion Cabinets

Signal Conditioning Amplifier System

MODEL A2-MC-8 CONTROLLER

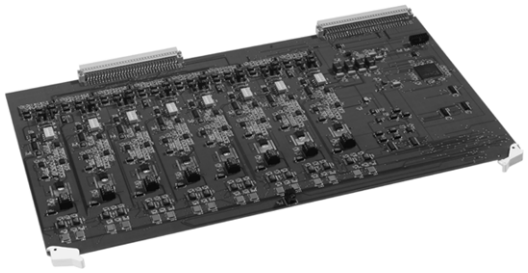
Supports hardware identification, setup and output data monitoring of each type of plug-in card via a local keyboard interface or remotely via an Ethernet Interface. Each controller supports 8 channels of signal conditioning and up to 128 channels of signal conditioning when expansion cabinets are added.

Front Panel User Interface:
Membrane keypad with illuminated 128 x 64 pixel FSTN positive, gray transflective LCD.

Communication Interface:
Physical: 10/100 Base-T
Protocol: HTTP
IP Addressing: Static. Configurable by the front panel controls

Size:
17" W X 12" D X 8.5"H [43.2cm W x 30.5cm D x 21.6cm H]

Weight:
12.6lbs [5.7kg]



MODEL A2-SG-8-BX STRAIN GAGE CARD

(Specify **Model A2-SG-8-BW** (with Butterworth filter characteristics) or **Model A2-SG-8-BS** (with Bessel filter characteristics).

These specifications apply for each of eight independent channels of signal conditioning per removable card.

Amp Input:

Inputs:
Quarter (120 ohms, 350 ohms, and 1000 ohms), half and full bridge (50-1000 ohms).
Bridge completion resistors are provided for quarter-bridge circuits.

Input Impedance:
>100 MΩ

Source Current:
±5nA typical; ±10nA max.

Amplifier:

Zero Temperature Stability:
±1.7μV/°C RTI*, ±100μV/°C RTO*, after 30-minute warm-up.

Input Range:
4 to 80mV full-scale input range (x2500 to x125) - adjustable by software control per channel.

Output Range:
±10V into 600Ω minimum load (When powered from 15VDC)

DC Gain Accuracy & Stability:
±0.10%; ±50ppm/°C

Common-Mode Rejection (DC to 100Hz):
105dB typical

Common-Mode Voltage:
±10V typical

Bandpass:
Full Power Frequency response DC to 110kHz; -3dB. (Wideband operation)
Slew Rate: 7V/μs

Dynamic Characteristics:

Noise RTI:
1μV p-p at 0.1Hz to 10Hz;
6μV RMS at 0.1Hz to 110kHz.

Total Harmonic Distortion:
0.014% at 1kHz

Filter:

Type:
Software settable 5th order filter - DC to 40kHz max: -3dB. (Butterworth or Bessel characteristics)

Settings:
Wideband, 40kHz, 20kHz, 10kHz, 5kHz, 1kHz, 100Hz, and 10Hz Software-programmable per channel.

Bridge Excitation:

Type:
Constant voltage

Settings:
0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10.0VDC.
Software-programmable per channel.

Accuracy:
±3mV typical

Signal Conditioning Amplifier System

Current:
50mA max. Over-current protected.

Load Regulation:
<0.05% of full scale for a load variation of 10% to 100% of full load.

Temperature Stability:
Better than ±0.005%/°C

Bridge Balance:
99% of measurement range

Calibration:
Standard factory-installed resistors (±0.1%) simulate 5000 microstrain at GF=2 for 120, 350 and 1000 ohm quarter bridge.

8 Channel Strain Gage Card Size:
15.13 inch W x 9 inch D [38.4cm W x 22.9cm D]

8 Channel Strain Gage Card Weight:
0.80lbs [0.36kg]

MODEL A2-TC-8-BX THERMOCOUPLE CARD

(Specify **Model A2-TC-8-BW** (with Butterworth filter characteristics) or **Model A2-TC-8-BS** (with Bessel filter characteristics).

These specifications apply for each of eight independent channels of signal conditioning per removable card.

Amp Input:

Inputs:
Thermocouple types J, K, T, E, N, R, S, B. Built-in electronic cold-junction compensation. Software-selectable.

Input Impedance:
10MΩ differential, 100KΩ common mode

Source Current:
±5nA typical; ±10nA max.

Amplifier:

Zero Temperature Stability:
±1.7 µV/°C RTI*, ±100 µV/°C RTO**, after 30-minute warm-up.

Input Range:
4 to 80mV full-scale input range (X2500 to X125) - adjustable by software control per channel.

Output Range:
±10V into 600Ω minimum load (when powered from 15VDC)

DC Gain Accuracy & Stability:
±0.05%; ±50ppm/°C

Common-Mode Rejection (dc to 100Hz):
105dB typical

Common-Mode Voltage:
±10V typical

Bandpass:
Full Power Frequency response DC to 110kHz; -3dB. (Filter not selected)
Slew Rate: 7V/µs

Dynamic Characteristics:

Noise RTI:
1 µVolt p-p at 0.1Hz to 10Hz;
6 µV rms at 0.1Hz to 110kHz.

Total Harmonic Distortion:
0.014% at 1kHz

Filter:

Type:
Software settable 5th order filter - DC to 40kHz: -3dB. (Butterworth or Bessel characteristics)

Settings:
Wideband, 40kHz, 20kHz, 10kHz, 5kHz, 1kHz, 100Hz, and 10Hz Software-programmable per channel.

8 Channel Thermocouple Card Size:
15.13 inch W x 9 inch D [38.4cm W x 22.9cm D]

8 Channel Thermocouple Card Weight:
0.80lbs [0.36kg]

MODEL A2-HL-8-BX HIGH LEVEL CARD

(Specify **Model A2-HL-8-BW** (with Butterworth filter characteristics) or **Model A2-HL-8-BS** (with Bessel filter characteristics).

These specifications apply for each of eight independent channels of signal conditioning per removable card.

Amp Input:

Inputs:
DC voltage (differential)

Input Impedance:
>100MΩ

Source Current:
±5nA typical; ±10nA max.

Amplifier:

Zero Temperature Stability:
±1.7µV/°C RTI*, ±100µV/°C RTO**, after 30-minute warm-up.

Input Range:
1 to 10V full-scale input range - adjustable by software control per channel.

Signal Conditioning Amplifier System

Output Range:
±10V into 600Ω minimum load (when powered from 15Vdc).

DC Gain Accuracy & Stability:
±0.10%; ±50ppm/°C

Common-Mode Rejection (dc to 100 Hz):
105dB typical

Common-Mode Voltage:
±10V typical

Bandpass:
Full Power Frequency response DC to 110kHz; -3dB. (Filter not selected)
Slew Rate: 7V/µs

Dynamic Characteristics:

Total Harmonic Distortion:
0.014% at 1Khz

Filter:

Type:
Software settable 5th Order filter - DC to 40kHz max: -3dB. (Butterworth or Bessel characteristics)

Settings:
Wideband, 40kHz, 20kHz, 10kHz, 5kHz, 1kHz, 100Hz, and 10Hz Software-programmable per channel.

Bridge Excitation:

Type:
Constant voltage

Settings:
0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10.0Vdc. Software-programmable per channel.

Accuracy:
±3mV typical

Current:
50mA max. Over-current protected.
Load Regulation:
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.005%/°C

8 Channel High Level Card Size:
15.13 inch W x 9 inch D [38.4cm W x 22.9cm D]

8 Channel High Level Card Weight:
0.80lbs [0.36kg]

*Referred to input **Referred to output

MODEL A2-EC-X EXPANSION CABINET

(Specify **Model A2-EC-8** (supports one addition instrumentation card) or **Model A2-EC-16** (supports two addition instrumentation cards) or **Model A2-EC-32** (supports four addition instrumentation cards).

Front View

Back View

Controller with Model A2-EC Expansion Cabinet

Stackable expansion cabinets are added when two or more instrumentation cards are used. Up to 16 instrumentation cards (128 channels) can be used with one Model A2-MC Master Controller. Control and power are routed via the Model A2-MC-8 Controller.

Expansion Cabinets Size:
Model A2-EC-8 Expansion Cabinet:
17" W X 12" D X 3.0" H [43.2cm W x 30.5cm D x 7.6cm H]
Model A2-EC-16 Expansion Cabinet:
17" W X 12" D X 5.0" H [43.2cm W 30.5cm D x 12.7cm H]
Model A2-EC-32 Expansion Cabinet:
17" W X 12" D X 9.5" H [43.2cm W x 30.5cm D x 24.1cm H]

Expansion Cabinets Weight:
Model A2-EC-8 Expansion Cabinet 4.5lbs [2.04kg]
Model A2-EC-16 Expansion Cabinet 6.8lbs [3.08kg]
Model A2-EC-32 Expansion Cabinet 12.0lbs [5.44kg]

MODEL A2 CONTROL AND MONITORING SOFTWARE

Recommended Browser (User Supplied): Internet Explorer version 6 or later, running under a Windows operating system (98, NT 4, 2000, or XP). A PC with Intel Pentium class, or better, processor (450 MHz or higher), 64MB RAM and a 100 Base-T Ethernet interface is recommended.

Signal Conditioning Amplifier

FEATURES

- Plug-in amplifier design; amplifiers are removable from the front panel without rear access
- Constant-voltage or constant-current excitation; 0.5 to 15V or 0.5 to 30mA; selectable by single internal switch
- Calibrated gain from 1 to 3300; adjustable front-panel gain switch and calibrated front-panel ten turn potentiometer
- Front-panel monitoring of: ±10V output; excitation; automatic balance status; and amplifier balance
- Automatic wide range-bridge balance with battery backup to retain balance in power-off condition
- Input coupling; selectable ac or dc by internal jumpers
- Fully grounded input amplifier; ±350Vdc or peak ac common-mode operating voltage
- Full-power bandwith of 100kHz at all gain settings; slew rate of 6.3V/µs
- Built-in four-pole Bessel low-pass filter with cutoff frequencies of 1Hz, 10Hz, 100Hz, 1kHz and 10kHz; front-panel frequency selection switch
- Two simultaneous buffered outputs; ±10 V and tape 1.0Vrms; will drive up to 0.15µF without instability
- Stable, proprietary bridge completion module for quarter- and half-bridge 120- and 350-ohm strain gage and transducer circuits
- 120-ohm dummy easily configured for 1000-ohm completion
- Built-in shunt calibration circuits; internal user-selectable configurations to provide two-point shunting of any bridge component or two-point double shunt calibration of transducers
- Optically isolated shunt calibration relays provided as standard; built-in power supply for relay operation is provided in ten-channel rack adapter and four-channel enclosure

DESCRIPTION

The 2200 Signal Conditioning System incorporates, as standard, all the features necessary for precise conditioning of strain gage and transducer inputs in the most severe operating environments.

The 2210A Amplifiers plug in from the front of the ten-channel 2250A Rack Adapter or four-channel 2260B Portable Enclosure without removing the rear-panel input connections.A single-channel adapter is also available.

Among the features of the 2210A Amplifier are isolated constant-voltage/constant-current excitation, guarded input structure with ±350V common-mode capability, ±10V and tape outputs, automatic wide-range bridge balance and four-pole Bessel low-pass filter.

Operating controls of the 2210A Amplifier are conveniently arranged and clearly marked to minimize the possibility of operator error. Constant-voltage or constant-current excitation, calibration configuration, and other optional operating modes are selected by easily accessible internal switches or jumpers.

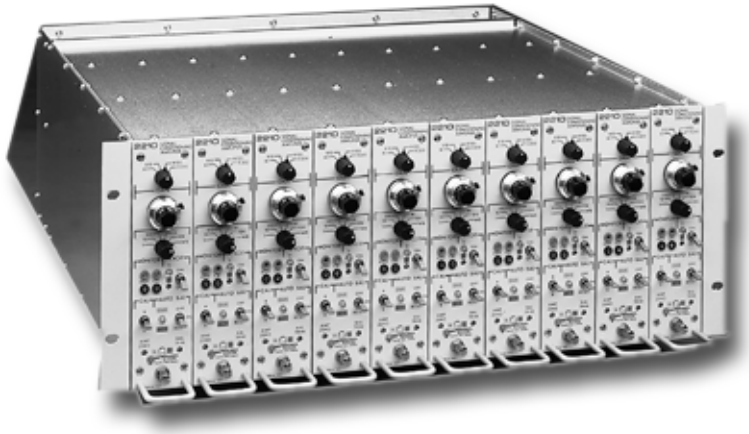
Typical 2200 System configurations are shown on the following page. Complete specifications are given on page 18.

Signal Conditioning Amplifier

The 2200 Signal Conditioning Amplifier Modules can be used as stand-alone single-channel units, or can be plugged into racks for multi-channel testing.

Single-channel conditioner amplifier with adapter for stand-alone use.

Portable enclosure accepts up to four signal conditioning/ amplifier modules.



Rack-mounted system allows assembly of signal conditioning amplifier modules for multi-channel testing. Ten-channel system shown in rack. All wiring is built-in to accept adjacent ten-channel systems.

Signal Conditioning Amplifier

2210A SIGNAL CONDITIONING AMPLIFIER SPECIFICATIONS

INPUT

Input Impedance:
dc-coupled: 22MΩ shunted by 250pF.
ac-coupled: 1.1µF in series with 20kΩ; low frequency cutoff (3dB) 8Hz norm.

Source Current: ±10nA typical; ±20nA maximum.

Configuration: 2- to 10-wire plus guard shield accepts quarter-, half-, or full-bridge strain gage or transducer inputs. Internal half-bridge, dummy 350Ω and dummy 120Ω completion gages, remove sense and four-wire calibration capability provided. 1000Ω completion capability also provided. Accepts inputs from ground-referenced or isolated devices.

Differantial Input: Maximum differantial input voltage of ±50Vdc or peak ac.

Common-Mode Input: Maximum common-mode input voltage of ±350Vdc or peak ac.

Guard Impedance: Greater than 250kΩ to output common; greater than 1000MΩ to power and rack ground.

AMPLIFIER

Gain: 1 to 3300; continuously variable; direct reading. Gain steps X1, X10, X100, X300; with 10-turn counting knob, X1 to X11. Accuracy ±0.5%.

Linearity: ±0.01% of full scale at dc.

Frequency Response:
dc to 100kHz: 3±0.2dB at all gain settings and full output
dc to 50kHz: 0.5dB max at all gain settings and full output
Gain Step vs Frequency Response (3 dB):

X300	100kHz	X10	135kHz
X100	120kHz	X1	240kHz

Slew Rate: 6.3V/µsec min at all gain settings.

Noise: (350Ω source impedance, dc-coupled)

Refered-to-Input (RTI):

1µV 0.1Hz to 10Hz p-p; 2µV 0.1Hz to 100Hz p-p

3µV 0.1Hz to 100kHz rms

Refered-to-Output (RTO): Output related noise is a function of the setting of the gain multiplier potentiometer.

Zero Stability: ±2µV RTI, ±200µV RTO at constant temp.

Temperature Coefficient of Zero: ±1µV/°C RTI, ±100µV/°C RTO; -10° to 60°C.

Common-Mode Rejection:

GAIN	CRM (dB)	GAIN	CRM (dB)
X1	82	X100	122
X10	102	X300	135

Common Mode Voltage: ±350Vdc or peak ac, max operating.

Standard Output: ±10V @ 10mA max;

Tape Output: 1.0Vrms @ 10mA max; or

Output ac-coupled: ±10V @ 10mA max (7Hz, 3dB).

Output Monitor: ±10V standard monitored via front-panel jacks.

Output Isolation: >1000MΩ from power and rack ground.

Output Protection: Protected against continuous short.

Capacitive Loading: Up to 0.15µF.

Low Pass Filter: Four-pole Bessel low-pass filter with selectable 3dB band-widths of 1Hz, 10Hz, 100Hz, 1kHz and 10kHz.

CONSTANT-VOLTAGE EXCITATION

Range: 0.50 to 15.0Vdc @ 85mA max.

Noise: 100µV + 0.002% of excitation p-p max dc to 20kHz.

Line Regulation: 200µV + 0.01% of excitation max for line voltage change of 10% from nominal.

Load Regulation: 200µV + 0.01% of excitation max for load variation of 10% of 90% of full load.

Stability: ±0.01%/°C or 100µV/°C, whichever is greater.

Remote Sense: Error <0.0005%/Ω of lead resistance.

Monitoring: Front-panel monitoring jacks.

Isolation: Isolated from power ground and output common; floats with guard.

CONSTANT-CURRENT EXCITATION

Range: 0.50 to 15.0mA dc or 1.00 to 30.0mA dc. Compliance voltage: 0.50 to 16.0V.

Noise: (1µA + 10µV) p-p; dc to 20kHz.

Line Regulation: ±1µA ± 0.01% max for line voltage change of ±10% from nominal.

Load Regulation: ±1µA ± 0.01% max for 100% load change.

Stability: ±0.01%/°C or 1µA/°C, whichever is greater.

Monitoring: Front-panel monitoring jacks; 10mV/mA.

Isolation: Isolated from power ground and output common; floats with guard.

Signal Conditioning Amplifier

BALANCE

Method: Electronically injected automatic balance.

Range: ±15 000με (7.5mV/V) RTI (X2 with internal jumper).

Resolution: 0.50με RTI (X2 with internal jumper)

Balance Time: 4 seconds typical; 8 seconds max.

Accuracy: ±2mV RTO; ±2με RTI.

Balance Trim: ±375με (188μV/V) RTI.

Storage: Digital with battery backup. Battery life 3-5 years.

Activation: Activated by front-panel switch or by optically isolated remote switch or low TTL level.

CALIBRATION

Four internal shunt calibration resistors, ±0.1% tolerance:

174.8K	1000με (0.50mV/V)	350Ω bridge;
874.8K	200με (0.10mV/V)	350Ω bridge;
59.94K	1000με (0.50mV/V)	120Ω bridge.

Activated by front-panel switch, or by optically isolated remote contact closure or low TTL level.

Internal selector switches for selection of two-point unipolar, bipolar, or two-point double shunt calibration circuits.

Calibration resistors plug into fixed terminals (no soldering).

SIZE & WEIGHT

7 H x 1.71 W x 17.88 D in (*178 x 43 x 454mm*).
3.7lb (*1.67kg*).

2231 DIGITAL READOUT MODULE SPECIFICATIONS

DISPLAY

LED's with ±19 999 counts full scale.

Overload Indications: Flashing zeroes and polarity.

SENSITIVITY/RESOLUTION

1mV per count.

INPUT CIRCUIT

Amplifier Configuration: Single-ended floating common.

Input Impedance: 2MΩ nominal.

Rear Connections: 8 channel via two INPUT connectors on the 2250A Rack Adapter or 2260B Portable Enclosure.

Front Connections: 1 channel standard banana jacks.

Input Selection: 9-position switch.

PEAK RETENTION CAPABILITY

Both positive-going (MAX) and negative-going (MIN) peaks are stored in two separate circuits independent of DISPLAY MODE selection. (The storage capability is always active.)

DISPLAY MODES

TRACK: Display follows input voltage.

PEAK HOLD: Displays one of the stored peak values.

MAX: Selects the MAX stored value.

MIN: Selects the MIN stored value.

ACCURACY

Step Input: ±0.1% ± 4 counts for step input up to 15V >4msec duration.

Repetitive Step Input: ±0.1% ± 4 counts for repetitive step inputs of >300μsec duration. Minimum number of steps required: 4msec ÷ pulse duration.

Repetitive Sine Wave: ±5% ± 4 counts for repetitive sine wave input of <1000Hz ± 0.5% ± 4 counts for repetitive sine wave input of <100Hz.

HOLD STABILITY

<1 count/minute typical, 2 counts/minute maximum at +75°F (*+23°C*), averaged over 5-minute period.

RESET CAPABILITY

Manual or automatic timed reset of MAX and MIN peaks. Optoisolator input requires 2 to 30V (<5mA @ 5V) for 0.1msec minimum.

POWER

115/230Vac, 50-60Hz, 10W max.

SIZE & WEIGHT

7 H x 3.44 W x 17.88 D in (*178 x 87.5 x 454mm*).
4.4lb (*2.0kg*)

All references to microstrain assume a gage factor of 2.00.

All specifications are nominal or typical at +23°C unless noted.

Signal Conditioning Amplifier

MODEL 2250A RACK ADAPTER

A prewired rack adapter which accepts up to ten Model 2210A plug-in amplifier modules. The Model 2250A also fits standard 19-in (*483-mm*) mainframe electronic equipment racks so that multi-channel system configurations can be conveniently housed. The Model 2250A contains all built-in wiring for connecting one rack adapter to another.

SPECIFICATIONS

Input: Input plugs are provided for up to ten channels; Bendix PT06A-14-15 (SR).

Output: Standard ±10V, BNC receptacle (10 ea). Tape 1.0Vrms, BNC receptacle (10 ea).

Remote: Provides access to remote calibration and remote balance functions of 2210A Amplifiers. The required +5V power supply is an integral part of the 2250A Rack Adapter.

Power: 115/230Vac, 50-60Hz, 120W max.
Fuse: 1.5A, 3 AG (115V) or 3/4A, 3 AG (230V)

Size: 7 H x 19 W x 18.87 D in (*178 x 483 x 479mm*).

Weight: 13.8lbs (*6.25kg*).

MODEL 2255 ENCLOSURE

An attractive sturdy cabinet for enclosing the rack-mounted multi-channel 2200 System. The 2255 Enclosure provides additional mechanical protection for the assembled system, and also permits increased portability.

SPECIFICATIONS

Size: 7.62 H x 19.75 W x 21.62 D in (*193 x 501 x 549mm*).

Weight: 20.2lbs (*9kg*).

MODEL 2260B PORTABLE ENCLOSURE

A self-contained prewired rack/enclosure which accepts up to four 2210A Amplifiers. All input/output connectors are provided on the rear panel of the enclosure. A carrying handle allows convenient portability, and a snap-down bail support on the bottom is used to elevate the 2260B for work efficiency during bench-top operation.

SPECIFICATIONS

Input: Input plugs are provided for up to four channels; Bendix PT06A-14-15 (SR).

Output: Standard ±10V, BNC receptacle (4 ea).
Tape 1.0Vrms, BNC receptacle (4 ea).

Remote: Provides access to remote calibration and remote balance functions of 2210A Amplifiers. The required +5V power supply is an integral part of the 2260B Portable Enclosure.

Power: 115/230Vac, 50/60Hz, 50W max.
Fuse: 3/4A, 3 AG (115V) or 3/8A, 3 AG (230V)

Size: 7.31 H x 7.20 W x 20.16 D in (*186 x 183 x 512mm*).

Weight: 8.1lb (*3.67kg*).

Signal Conditioning Amplifier

MODEL 2270A SINGLE-CHANNEL ADAPTER

Pemits use of a stand-alone single-channel 2210A Amplifier. The plug-in adapter provides for the power and input/output connectors.

SPECIFICATIONS

Input: Input plug is provided; Bendix PT06-14-15 (SR).

Output: Standard ±10V, BNC receptacle. Tape 1.0Vrms, BNC receptacle.

Remote: Provides access to remote calibration and remote balance functions of 2210A Amplifier. The required +5V power supply must be provided by the user.

Power: 115/230Vac, 50-60Hz, 12W max.
Fuse: 3/8A, 3 AG.

Size: 7.06 H x 3.20 W x 4.90 D in (*180 x 81 x 125mm*).

Weight: 0.8lbs (*0.36kg*).

THE 2200 SYSTEM PROVIDES BETTER DATA:

A **floating**, **guarded input** environment maximizes the rejection of common-mode voltages up to **±350V** (operating). The input amplifier can also be ac-coupled for situations where only dynamic signals are of interest.

The **independent**, **isolated bridge excitation** system provides either **constant-voltage** or **constant-current** excitation. A front-panel LED serves as a supervisory indicator, and a front-panel switch removes bridge excitation to assist in evaluation of circuit integrity.

An **automatic balance** circuit is used to provide wide balance range and **electronic injection** of balance voltage. This feature eliminates transducer loading and assures sufficient balance capability for practically all input configurations. The automatic balance circuit can be disabled from the front panel to allow measurement of initial unbalance, input noise, thermal offsets or zero shifts.

The **four-pole Bessel low-pass filter** provides five selectable bandwidths from **1Hz to 10kHz**. The 1Hz or 10Hz positions can be used for quasi-static data with excellent rejection of line frequency (60Hz) noise. The output of the low-pass filter can be routed to either the standard or tape output, or either output can be wideband.

Wide bandwidth and **high slew rate** at all gain settings and at **full output** (±10V). This characteristic ensures that integrity of the system's performance is not compromised when higher gain settings are required.

A **standard** (±10V) and a **tape** (1.0Vrms) output are provided for each channel. The outputs are **isolated** from the guarded input and from chassis (system) ground. This feature gives the user complete independence to establish a high-quality instrumentation ground system at the recording or data acquisition site. Both outputs can drive long (high capacitance) coaxial cables without instability.

The system provides **optically isolated shunt calibration circuits** on each channel. Any desired calibration configuration can be selected by internal switches. External contact closures are also accessible via the input connector to facilitate double-shunt (two-level) transducer calibration. Calibration resistors can easily be changed to any special values. No soldering is required.

Individual amplifiers are **removable from the front panel** without disconnecting the input or output wiring. This gives the user the option of dedicated rack or enclosure wiring, sharing of amplifiers, and ease of amplifier replacement under emergency conditions.

Signal Conditioning Amplifier

FEATURES

- Accepts all strain gage inputs (foil and piezoresistive), potentiometers, DCDT's, etc
- Selectable bridge excitation, 0.7 to 15Vdc (11 steps), plus 0.2 to 7Vdc continuously variable
- Fully adjustable calibrated gain from 1 to 11 000
- Dual-range (±5000με and ±25 000με) automatic bridge balance, with "keep-alive" power to preserve balance for months without external power
- All bridge completion built in, including 120- or 1000- and 350-ohm dummies
- Dual polarity two-step double shunt calibration
- Bandpass:
  - 60kHz (-0.5dB)
  - 140kHz (-3.0dB)
- Switchable active filter - a 6-pole Butterworth is standard
- Two simultaneous buffered outputs
- Playback mode to filter and observe or re-record previously recorded low-level data
- Input impedance above 100 megohms

DESCRIPTION

The 2300 System conditions and amplifies low-level signals to high-level outputs for multiple-channel, simultaneous dynamic recording and display on external devices.

Among its features, each 2310B Module includes a built-in power supply, active filtering, two simultaneous outputs, playback mode, wide frequency response, and voltage injection bridge balance.

Up to ten 2310B Modules can be mounted in a Model 2350 Rack Adapter; or up to four modules in a Model 2360B Portable Enclosure; or, a single 2310B can serve as a stand-alone unit using the 2310-A20 Line Cord and Stabilizer.

Signal Conditioning Amplifier

MODEL 2310B SIGNAL CONDITIONING AMPLIFIER

The 2310B Conditioner/Amplifier Modules accept inputs from strain gages, load/pressure/dc displacement transducers, potentiometers, RTD's and nickel temperature sensors, without any internal modification.

Controls on the 2310B are arranged in sections, permitting easy setup. Clearly marked push-button and single-purpose switches minimize the possibility of operator error during use. With the exception of the playback switch, all operational and monitor controls are on the front panel. Switches for selecting remote sense and specific shunt calibration configurations are located on the printed circuit board inside the unit.

Front Panel

- Calibration: Momentary two-position switches, ±A and ±B, control shunt calibration levels; 4 point.
- LED Display: Set up indicator for amplifier balance, bridge balance and for monitoring the output polarity.
- Filter Section: Push-button controls for activating appropriate low- and high-pass active filters.
- Electronic Bridge Balance Section: Three-position switch--OFF, ON, RESET--for electronic bridge balance; auto ranging up to ±25 000με with nonvolatile zero storage; yellow light indicates high-range operation or over range condition.
- Vernier trim control is used to refine bridge balance when desired.
- AC IN: Capacitive coupling in the amplifier; eliminates static component of the signal.
- Bridge Excitation: ON-OFF switch for removing bridge excitation from the strain gage or transducer for noise documentation.
- Amplifier Balance: Adjusts amplifier offset.
- Excitation Level: Twelve-position switch; values arranged for doubling power with each step, with one 0.2 to 7Vdc continuously variable.
- Amplifier Gain Section: Continuously variable potentiometer (1.00 to 11.00) plus push-button course gain multipliers control amplifier gain; direct-reading.
- Battery Test: Momentary push button determines battery level for bridge zero storage.
- Main Power: Turns unit on/off; LED pilot light.
- Pin Jacks: Monitoring of Excitation, Unamplified Input, Amplified Output.

Signal Conditioning Amplifier

Rear Panel

- AC Line Switch: Selects nominal 115 or 230Vac operation.
- Playback Section: Slide switch activates playback operating mode. Connects the input to the filter circuits and post amplifiers. BNC input connector.
- Low-level Output: Full-scale ±1.4V level available at this BNC connector for driving various recording devices and low-level analog-to-digital converters.
- High-Level Output: Full-scale ±10V level available at this BNC connector for driving an oscilloscope, digital volt-meter, analog-to-digital converter, etc.
- Input Receptacle: All sensor inputs made through this 15-pin quarter-turn connector. Pin selection determines mode of operation (mating plug included).
- Power Connector: Main power input from the rack adapter, portable enclosure or individual line plug. Additional pins for optional remote operation of shunt calibration, bridge excitation (ON/OFF), and electronic bridge balance.

SPECIFICATIONS

All specifications are nominal or typical at +23°C unless noted. Performance may be degraded in the presence of high-level electromagnetic fields.

INPUT:

Strain gages: quarter, half or full bridge (50 to 1000Ω). Built-in 120Ω and 350Ω dummy gages; 1000Ω dummy capability.

Transducers: foil or piezoresistive strain gage types; DCDT displacement transducers; potentiometers.

EXCITATION:

Eleven fixed settings: 0.7, 1, 1.4, 2, 2.7, 3.5, 5, 7, 10, 12 and 15Vdc ±1% max.

One variable setting: 0.2 to 7Vdc

Current: 0-100mA, min, limited at 175mA, max.

Regulation (0-100mA ±10% line change): ±0.5mV ±0.04%, max measured at remote sense points. (Local sense: -5mV, typical, @ 100mA, measured at plug.)

Remote sense error: 0.0005% per Ω of lead resistance (350Ω load).

Noise and ripple: 0.05% p-p, max (dc to 10kHz).

Stability: ±0.02%/°C.

Level: normally symmetrical about ground; either side may be grounded with no effect on performance.

BRIDGE BALANCE:

Method: counter-emf injection at pre-amp; automatic electronic; dual range; can be disabled on front panel.

Ranges (auto ranging):
±5000με (±1% bridge unbalance or ±2.5mV/V), resolution 2.5με (0.0012mV/V).
±25 000με (±5% bridge unbalance or ±12.5mV/V), resolution 12.5με (0.006mV/V).

Balance time: 2 seconds, typical.

Signal Conditioning Amplifier

Manual vernier balance range: 100με (0.050mV/V).

Interaction: essentially independent of excitation and amplifier gain.

Storage: non-volatile digital storage without line power for up to two years.

SHUNT CALIBRATION:

Circuit (two-level, dual polarity): Single-shunt (for stress analysis) across any bridge arm, including dummy gage.

Double-shunt (for transducers) across opposite bridge arms.

Provision for four dedicated leads to shunt external arms.

CAL circuit selected by switches on p.c. board.

Standard factory-installed resistors (±0.1%) simulate:
±200 and ±1000με @ GF=2 across dummy half bridge;
±1000με @ GF=2 across dummy gage (120Ω and 350Ω).
±1mV/V (double shunt) for 350Ω transducer

Remote-operation relays (Option Y): four relays (plus remote-reset relay for bridge balance and relay for excitation on/off). Each relay requires 10mA @ 5Vdc, except excitation on/off 25mA.

AMPLIFIER:

Gain: 1 to 11 000 continuously variable. Direct reading, ±1% max. 10-turn counting knob (X1 to X11) plus decade multiplier (X1 to X1000)

Frequency response, all gains full output:
dc coupled: dc to 145kHz, -3dB max.
dc to 60kHz, -0.5dB max.
ac coupled: 1.7Hz typ. to 150kHz, -3dB max.

Frequency response versus gain, full output:

GAIN	-0.5dB	-3dB
1-11	130kHz	300kHz
10-110	110kHz	250kHz
100-1100	80kHz	160kHz
1000-11000	76kHz	155kHz

Slew rate: 7.8V/μs typical

Input impedance: 100mΩ, min, differential or common-mode, including bridge balance circuit.

Bias current: ±40nA, typical max., each input.

Source impedance: 0 to 1000Ω each input.

Common-mode voltage: ±10V.

Common-mode rejection (gain over X100):
Shorted input: 100dB, min, at dc to 60Hz;
90dB, min, dc to 1kHz;
350Ω balanced input: 90dB, typical, dc to 1kHz.

Stability (gain over X100):
±2μV/°C, max, RTI (referred to input).

Noise (gain over X100, all outputs):
0.01 to 10Hz: 1μV p-p RTI.
0.5 to 125kHz: 6μVrms, max, RTI.

FILTER:

Characteristic:
Low-pass active six-pole Butterworth standard.

Frequencies (-3 ±1dB): 10, 100, 1000 and 10 000Hz and wide-band.

Outputs filtered: either one or both (switch-selected on printed circuit board).

AMPLIFIER OUTPUTS:

Standard output: ±10V @ 5mA, min.
Slew Rate: 7.8V/μs (typical)

Low-level output: ±1.414V (1Vrms) @ 5mA, min.

Linearity @ dc: ±0.02%.

Either output can be short-circuited with no effect on the other.

PLAYBACK:

Input: ±1.414V full scale; input impedance 20kΩ.

Gain: X1 to low-level output; X7.07 to standard output.

Filter selection: As specified above.

Outputs: Both as specified above.

OPERATING ENVIRONMENT:

Temperature: 0° to +50°C.

Humidity: 10 to 90%, noncondensing.

POWER:

105 to 125V or 210 to 250V (switch-selected), 50/60Hz, 10 watts, max.

Keep-alive supply (for bridge balance): Lithium 3.6V, 1/2AA or equal. Shelf life approximately two years.

SIZE & WEIGHT:

Panel: 8.75 H x 1.706 W in (222.2 x 43.3mm).

Case depth behind panel: 15.9 in (404mm).

Weight: 6lb (2.7kg).

Signal Conditioning Amplifier

MODEL 2350 RACK ADAPTER

A prewired rack adapter which accepts up to ten Model 2310B plug-in amplifier modules. The Model 2350 also fits standard 19-in (483mm) mainframe electronic equipment racks so that multi-channel system configurations can be conveniently housed

SPECIFICATIONS

APPLICATION:

Fits standard 19-in (483-mm) electronic equipment rack.

Accepts up to ten 2310B Amplifiers. AC line completely wired.

Wiring for remote calibration with Option Y.

POWER:

115 or 230 Vac switch selected in amplifiers, 50/60Hz, 100 Watts max.

SIZE & WEIGHT:

8.75 H x 19 W x 19.06 D overall (222 x 483 x 484mm).

13.5lb (6.1kg).

MODEL 2355 10-CHANNEL ENCLOSURE

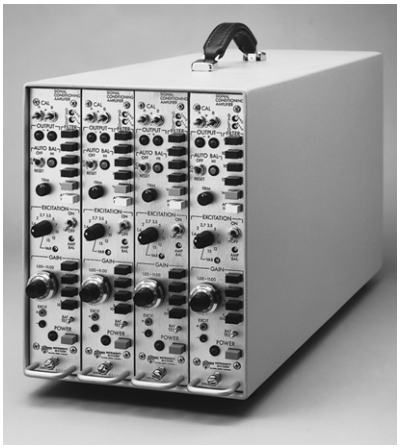
An attractive sturdy cabinet for enclosing the rack-mounted multi-channel 2300 System. The 2355 Enclosure provides additional mechanical protection for the assembled system, and also permits increased portability. Must be used in conjunction with a Model 2350 Rack Adapter.

SPECIFICATIONS

WEIGHT: 6lb (2.7kg).

Signal Conditioning Amplifier

MODEL 2360B 4-CHANNEL ENCLOSURE



Model 2360B Portable Enclosure includes all ac wiring. Accepts up to four amplifier modules.

SPECIFICATIONS

APPLICATION:

Enclosure to accept up to four 2310B Amplifiers.

AC wiring complete.

Wiring for remote calibration with Option Y.

POWER:

115 or 230Vac (switch selected in amplifiers), 50/60Hz, 100 Watts max.

SIZE & WEIGHT:

9.06 H x 7.20 W x 18.90 D in (229 x 183 x 480mm)

6.75lb (3.1kg).

micro-measurements@vishay.com

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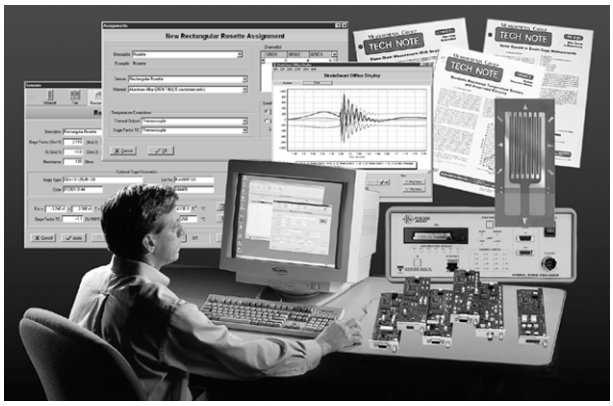
Digital Data Systems

StrainSmart® Data Acquisition System



StrainSmart is a ready-to-use, Windows®-based software system for acquiring, reducing, presenting, and storing measurement data from strain gages, strain-gage-based transducers, thermocouples, temperature sensors, LVDT's, potentiometers, piezoelectric sensors, and other commonly used transducers.

And, it is designed to function seamlessly with a variety of Vishay Measurements Group instrumentation hardware, including System 5000, System 6000, and System 7000 StrainSmart Data Systems.

DESCRIPTION

Ready-to-use StrainSmart software makes test setup fast and easy for strain gages, strain-gage-based transducers, thermocouples, temperature sensors, LVDT's, potentiometers, piezoelectric sensors, and other commonly used transducers. Using the parameters input for sensors, materials, and instrumentation hardware, StrainSmart automatically outputs the results of the test data in engineering units. Test setups and measurement data can also be permanently stored for offline display or for use in databases, word processors, and spreadsheets.

StrainSmart has the capability to reduce data in both the time and frequency domains. FFT analysis may be elected for data acquired at scanning rates of 100 samples per second, or more.

Accurate strain measurements require attention to the unique characteristics of the strain gage and measurement system – thermal output, temperature coefficient of gage factor, and transverse sensitivity of strain gages, as well as nonlinearity errors inherent in the Wheatstone bridge. StrainSmart software takes these into account automatically.

All strain-gage bridges are scaled for the number of active bridge arms. Data from measurements with delta, rectangular, and tee rosettes can be reduced to principal strains and stresses, as well as the equivalent stresses for common failure mode criteria.

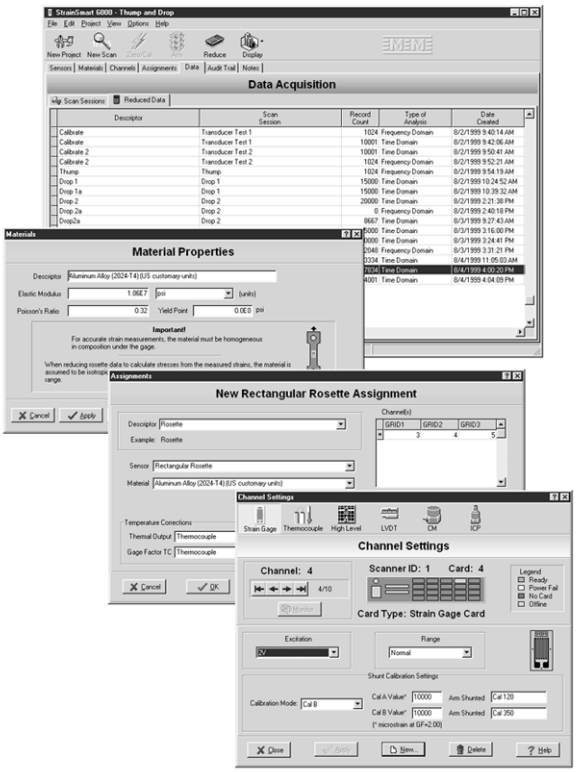
Fully reduced and corrected measurement data can be monitored online, and recorded at predetermined limits or at user-defined intervals.

THE STRAINSMART ADVANTAGE

Strain gage technology is the stress/strain measurement technique most widely used around the world. Over the years, we have developed the tools necessary for accurate acquisition and understanding of strain gage measurements. The primary factors affecting strain gage and instrument performance are incorporated into our extensive selection of Tech Notes, Application Notes, Instruction Bulletins, and other technical publications that are recognized and used as the authoritative references for strain gage measurement by practitioners throughout the world. StrainSmart software automatically applies the techniques and corrections covered by these publications to your test measurements.

StrainSmart® Data Acquisition System

STRAINSMART SOFTWARE FEATURES



- Complete Windows-based software designed for the experimental stress analyst.
- Easy-to-use StrainSmart Wizards for fast test setup and for data acquisition, reduction, and presentation.
- Sensor-specific assignment of inputs (strain gages, thermocouples, etc.), as well as user-defined assignments for mathematical manipulation of measurement data.
- One-touch autobalance.
- Shunt calibration of strain-gage inputs.
- Reduced data available offline as Paradox data tables, ASCII text, HTML or Microsoft Office (Word, Excel, Access) document, or online by OLE Automation connection to spreadsheets, word processors, LabView, and other third-party applications.
- Online interactive Help system.
- Test setup and commonly used parameters available for saving and reuse for subsequent testing.

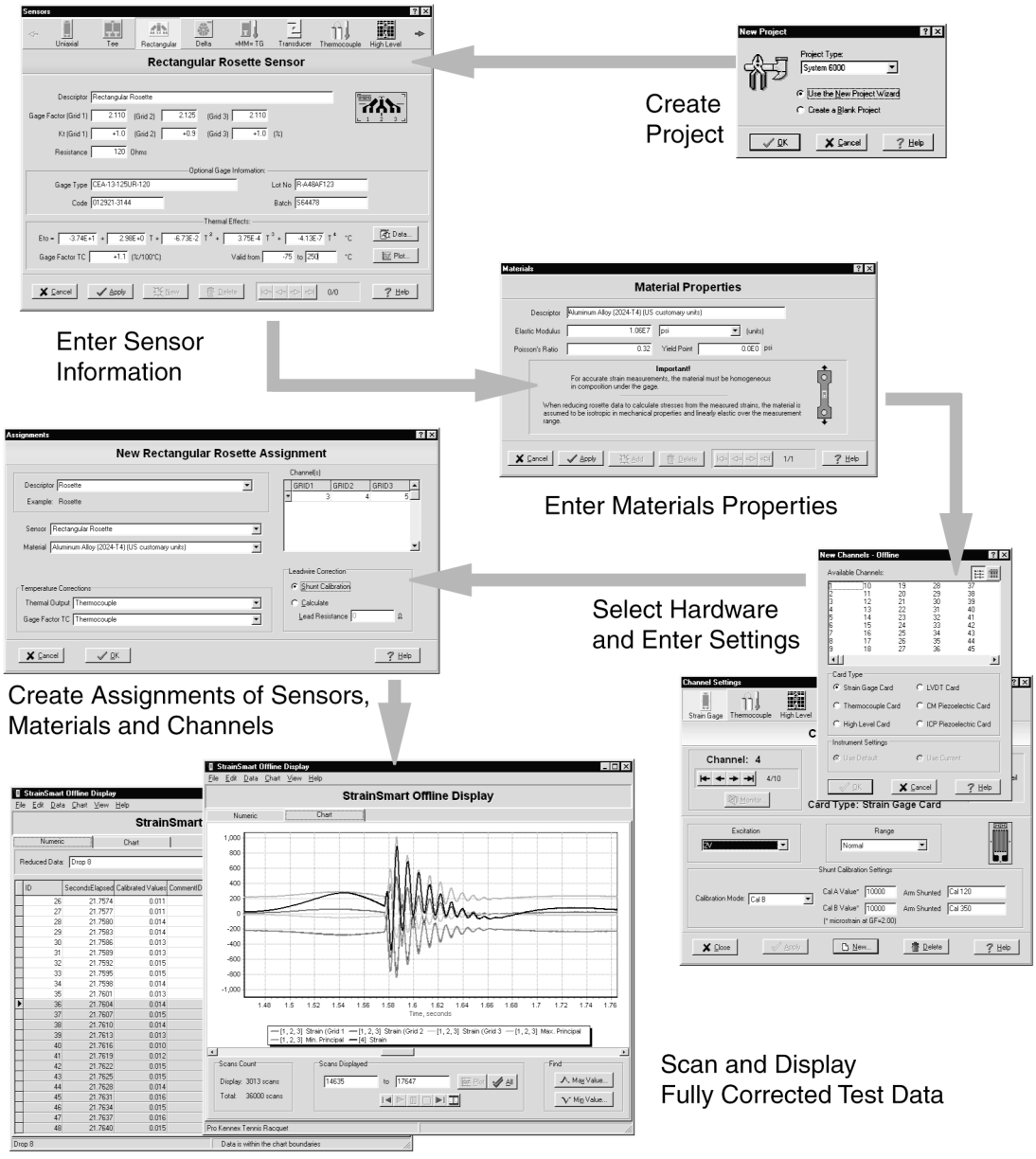
ACQUISITION/REDUCTION/PRESENTATION

- Data reduction for delta, rectangular, and tee rosettes, including the conversion of principal strains to stresses.
- Calculation of equivalent stresses for common failure mode criteria.
- Online monitoring of key channels and/or rosettes in fully reduced and corrected numeric and graphic formats.
- Offline presentation of all reduced data in numeric and graphical formats.
- FFT analysis (System 6000 and System 7000).
- Thermal output compensation.
- Correction for temperature coefficient of gage factor.
- Wheatstone bridge nonlinearity correction.
- Transverse sensitivity correction.
- Thermocouple linearization.
- Scaling for number of active bridge arms.
- Data storage for later analysis and processing.
- Record on limits or user-defined time intervals.
- Automatic audit trail.
- Self calibration (System 7000).
- Barcode input of strain gage datasheet information.

StrainSmart® Data Acquisition System

MULTI-CHANNEL MEASUREMENTS

Through StrainSmart software, the appropriate setup information is entered - gage factor, materials properties, transducer sensitivities, etc. Using these parameters, StrainSmart automatically outputs the results of test data in engineering units. Setup information and measurement data can also be permanently retained for offline display or for export to databases, word processors, and spreadsheets.

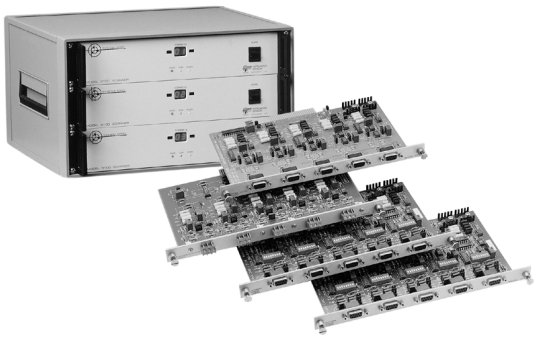

Create Project
Enter Sensor Information
Enter Materials Properties
Select Hardware and Enter Settings
Create Assignments of Sensors, Materials and Channels
Scan and Display Fully Corrected Test Data

StrainSmart® Data Acquisition System

STRAINSMART DATA SYSTEMS

StrainSmart software is designed to function with a variety of instrumentation hardware to meet your needs

System 5000

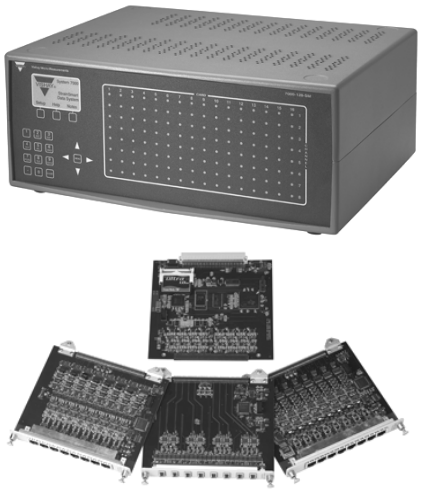


- Up to 50 measurements per second per sensor

System 6000

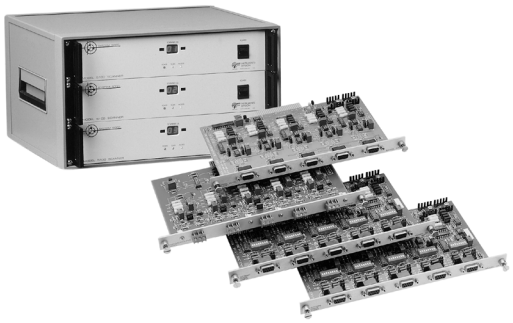
- 10 to 10,000 measurements per second per sensor
- Selectable digital filtering of measurement signals
- Time and frequency domain analysis
- Desktop and remote operation

System 7000



- 10 to 2048 measurements per second per sensor
- Selectable digital filtering of measurement signals
- Time and frequency domain analysis
- Self calibration with internal calibration reference

StrainSmart® Data Acquisition System



FEATURES

- From 5 to 1200 input channels - can be configured as needed at any time
- Inputs accepted from strain gages and strain-gage-based transducers (Model 5110A), thermocouples (Model 5120A), sensors with high-level voltage output (Model 5130B), and LVDT's (Model 5140A)
- Built-in bridge completion for 120-, 350-, and 1000-ohm strain gages
- Scanning and recording intervals as short as 0.02 seconds for up to 1200 inputs
- Stable, accurate, low-noise signal conditioning
- Available with PCI and/or PCMCIA hardware Interfaces

DESCRIPTION

System 5000's Model 5100B Scanners acquire test data within 1 millisecond from up to 1200 channels at scan intervals as short as 0.02 seconds. This translates into more accurate test results, and the ability to capture data under static loading conditions immediately before failure.

Sensor connections are quickly made to the cards at the rear of each scanner in System 5000. Strain gage cards include built-in bridge completion for quarter and half bridges, and a constant voltage power supply for 0, 0.5, 1, 2, 5, and 10Vdc bridge excitation.

System 5000's instrumentation hardware is designed to incorporate all the features required for precision strain measurement under static loading conditions, while maintaining flexibility and ease of use. A system can be configured with as few as 5, and as many as 1200, sensors. Since each Model 5100B Scanner can function independently, your System 5000 components can easily be configured with StrainSmart software for each test requirement.

MODEL 5100B SCANNER SPECIFICATIONS

The Model 5100B Scanner is sized for standard 19-in (483-mm) instrumentation racks. Cabinets are available for various system configurations for bench-top or field use.

Since each Model 5100B Scanner can function independently, your System 5000 components can be easily configured for each test requirement. A 100-channel system, for example, can be used as five independent 20-channel systems simply by purchasing additional interface hardware installations.

INPUTS:
Accepts up to four cards (five channels per card and up to 20 channels per scanner).

A/D CONVERTER:
16-bit (15-bit plus sign) successive approximation converter. Usable resolution is typically 15 bits. 40 μs total conversion time per reading.

SCAN RATE:
1ms per scan. Fifty complete scans per second typical usage. Concurrent scanning for all scanners.
Input channels in each single scanner are scanned sequentially at 0.04-ms intervals and stored in random access memory within a 1-ms window.

DIGITAL OUTPUT: NO and NC relay contacts (500mA at 30Vdc into a resistive load).

OPERATIONAL ENVIRONMENT:
Temperature:-10° to +50°C
Humidity: Up to 90% RH, non-condensing

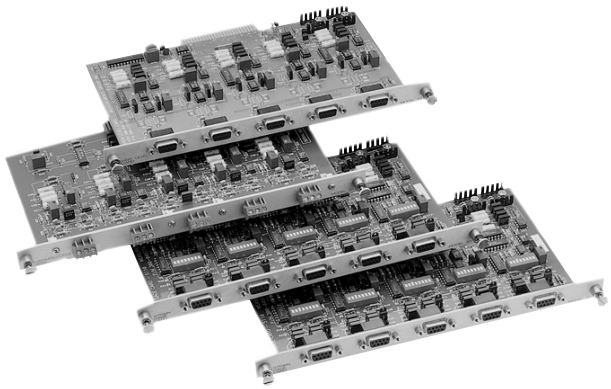
SIZE:
3.5 H x 19 W x 16 D in (89 x 483 x 381mm)

WEIGHT:
16lb (7.25kg)

POWER:
115 or 230Vac user-selectable;
±10% of setting; 50/60Hz; 140W max.

StrainSmart® Data Acquisition System

SENSOR CARD SPECIFICATIONS



Strain gages, strain-gage-based transducers, thermocouples, LVDT's, potentiometers and other transducers can be intermixed in multiples of 5 by choosing the appropriate sensor card.

MODEL 5110A STRAIN GAGE CARD

CHANNELS: Five per card.

INPUTS:

Strain Gages:
120Ω, 350Ω,1000Ω quarter bridges; 60Ω to 5000Ω half and full bridges.
Jumper-selectable completion resistors (0.02% ± 3ppm/°C typ).

Measurement Range:
Normal range mode: ±16 380με
High range mode: ±163 800με
Low range mode: ±1638με

Resolution:
Normal range mode: 1με
High range mode: 10με
Low range mode: 0.1με

Strain Gage Based Transducers:
60Ω to 5000Ω impedance

Measurement Range:
Normal range mode: ±8mV/V
High range mode: ±80mV/V
Low range mode: ±0.8mV/V

Resolution:
Normal range mode: 0.5μV/V
High range mode: 5.0μV/V
Low range mode: 0.05μV/V

Input Impedance:
220MΩ each input.

Input Protection: ±40V

Source Current: ±25nA max.

Input Connector: Nine-pin D-sub style.

AMPLIFIER:

Zero Temperature Stability:
±1.2μV/°C RTI, ±100μV/°C RTO, after 30-minute warm-up.

Gain Accuracy & Stability:
±0.1% at +23°C; ±100ppm/°C

Common-Mode Voltage:
±10V

Common-Mode Rejection (dc to 5Hz):
100dB typical

System Noise (Normal Mode Operation):
±2με typical (±4ADC counts)

System Coarse Balance Range:
±100% of measurement range (typically ±16 383με)

CALIBRATION:
Two shunt calibration points are available on each channel.
Switch-selectable.
Calibration switches, A and B, are software selectable.

EXCITATION:
0.0, 0.5, 1.0, 2.0, 5.0, and 10.0Vdc.
Software-programmable.

Accuracy:
±5mV typical

Current:
250mA max. (50mA per channel).
Over-current protected.

Load Regulation:
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.005%/°C

FILTER:

Type:
Four-pole Butterworth

Cutoff Frequency (-3dB):
5HZ

StrainSmart® Data Acquisition System

MODEL 5120A THERMOCOUPLE CARD

CHANNELS: Five per card.

INPUTS:
Thermocouple types J, K, T, E, R, S, and B.
Built-in electronic cold-junction compensation.
Software-selectable
Open sensor detection

Input Impedance: 22MΩ each input.
Input Protection: ±40V
Source Current: ±0.5nA typical; ±5nA max

INPUT CONNECTOR:
Removable three-position screw terminal

AMPLIFIER:

Zero Temperature Stability:
±1.2μV/°C RTI, ±100μV/°C RTO, after 30-minute warm-up.

Gain Accuracy & Stability:
0.1% ±100ppm/°C

Common-Mode Rejection (dc to 5Hz):
100dB typical

Common-ModeVoltage:
±10V

System Noise (Normal Mode Operation):
±10μV typical (±4ADC counts)

MEASUREMENT RANGE: ±81.9mV

RESOLUTION: 2.5μV

FILTER:

Type:
Four-pole Butterworth

Cutoff Frequency (-3dB):
5HZ

MODEL 5130B HIGH-LEVEL INPUT CARD

CHANNELS: Five per card.

INPUTS: DC volts (differential)

Input Impedance: 22MΩ each input.
Input Protection: ±40V
Source Current: ±0.5nA typical; ±5nA max

INPUT CONNECTOR: Nine-pin D-sub style

AMPLIFIER:

Zero Temperature Stability:
±1.2μV/°C RTI, ±100μV/°C RTO, after 30-minute warm-up.

Gain Accuracy & Stability:
0.1% ±100ppm/°C

Common-Mode Rejection (dc to 5Hz):
100dB typical

Common-ModeVoltage:
±10V

System Noise (Normal Mode Operation):
± 4ADC counts typical (0 to 15V excitation).
±10ADC counts typical (20 to 30V excitation)

MEASUREMENT RANGES: ±1, ±2, ±5, ±10Vdc

RESOLUTION: 30.5, 61, 152.5, 305μV

EXCITATION:
0, 0.5, 1.0, 2.0, 5.0, 10.0, 15.0, 20.0, 25.0 and 30.0Vdc

Accuracy:
±10mV typical

Current:
250mA max (50mA per channel) at 1 to 15V.
200mA max (40mA per channel) at 20V.
150mA max (30mA per channel) at 25 to 30V.

Over-current protected.

Max current limit selected by jumpers.

Load Regulation:
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.005%/°C

FILTER:

Type:
Four-pole Butterworth

Cutoff Frequency (-3dB):
5HZ

MODEL 5140A LVDT INPUT CARD

CHANNELS: Five per card.

INPUTS: Three- to six-wire transducers

Input Impedance: 10MΩ each input.
Input Protection: ±40V
Source Current: ±0.5nA typical; ±5nA max

INPUT CONNECTOR: Nine-pin D-sub style

AMPLIFIER:

Zero Temperature Stability:
±1.2μV/°C RTI, ±100μV/°C RTO, after 30-minute warm-up.

Gain Accuracy:
0.25% typical

Common-Mode Rejection (dc to 5Hz):
100dB typical

Common-ModeVoltage:
±10V

System Noise (Normal Mode Operation):
±4ADC counts typical

StrainSmart® Data Acquisition System

MEASUREMENT RANGES: ±0.5, ±1, ±2.5, ±5Vrms

RESOLUTION: 15.25, 30.5, 76.2, 152.5 μVrms

CALIBRATION: Excitation sample

EXCITATION:
3.0Vrms, 5000Hz or 2500Hz sine wave.
Software-selectable

Accuracy:
±5mVrms typical

Current:
±250mA max (±50mA per channel).
Over-current protected

Load Regulation:
<0.1% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.05%/°C

FILTER:

Type:
Four-pole Butterworth

Cutoff Frequency (-3dB):
5HZ

StrainSmart® Data Acquisition System

FEATURES

- From 1 to 1200 input channels
- Individual input cards for strain gage and strain-gage-based transducers (Model 6010A), thermocouples (Model 6020), sensors with high-level voltage outputs (Model 6030A), LVDT's (Model 6040A), piezoelectric sensors (Model 6050), and digital tachometer (Model 6095)
- Built-in bridge completion for 120-, 350-, and 1000-ohm strain gages
- Maximum scan rate of 10 000 samples per second per channel; maximum throughput of 200 000 samples per second
- Simultaneous sampling with anti-aliasing filter and analog-to-digital conversion for each channel
- Stable, accurate, low-noise signal conditioning
- Selectable digital filtering of measurement signals
- High-speed PCI hardware interface (Model 6100) and Ethernet network interface (Model 6200A)
- Digital I/O for triggering external events

DESCRIPTION

System 6000 features data acquisition rates of up to 10,000 samples per second per channel. The hardware is designed to incorporate all the features required for precision strain measurement under a variety of loading conditions, while maintaining flexibility and ease of use. A system can be configured with 1 to 1200 sensors. Strain gages, strain-gage-based transducers, thermocouples, LVDT's, potentiometers, accelerometers, piezoelectric sensors and other transducers can be intermixed by choosing the appropriate sensor card. All System 6000 components can be easily configured for each test requirement. Both the Model 6100 Scanner (holding up to 20 input cards) and the Model 6200A Scanner (holding up to 16 input cards) function independently. Additionally, the smaller, lighter, portable Model 6200A can operate from a variety of dc power sources, and can be configured to remotely perform data acquisition and storage.

Utilizing the benefits of individual analog-to-digital conversion on each channel and simultaneous sampling data acquisition for all channels, System 6000's Model 6100 Scanners record test data at rates of up to 10,000 samples per second per channel of instrumentation hardware. The PCI hardware interface between the scanners and a PC running Strain-Smart software in the Windows NT/2000/XP environment enables a combined throughput of up to 200 000 samples per second for all channels (for example, 20 channels at 10 000 samples per second per channel or 40 channels at 5000 samples per second per channel).

Selectable, digital FIR low-pass filtering is incorporated into each instrumentation channel to meet a variety of testing requirements. Custom filters are also available.

StrainSmart® Data Acquisition System

MODEL 6100 SCANNER SPECIFICATIONS

- AC powered
- 19-in rack-mountable, 3.5-in high package
- Accepts up to 20 plug-in input cards
- Support high-speed data transfer and setup of the plug-in cards
- Supports local diagnostics
- Supports software identification and setup of each type of plug-in card

OPERATION:
Direct software control.

INPUTS:
Accepts up to 20 cards (one channel per card and up to 20 channels per unit).

SYNC: Automatic

DATA STORAGE: None.

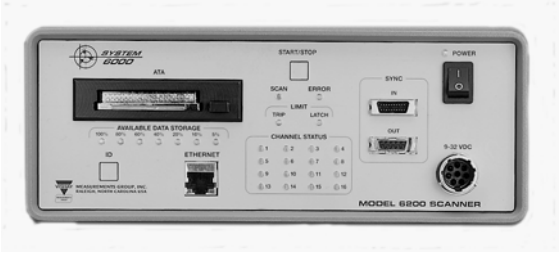
INTERFACE: Proprietary PCI.

SIZE:
3.5 H x 19 W x 16 D in (89 x 483 x 381mm)

WEIGHT:
17lb (7.7kg) empty
19.5lb (8.8kg) loaded with 20 plug-in cards

POWER:
115 or 230Vac user-selectable; ±10% of setting; 50/60Hz; 200W max.

MODEL 6200A SCANNER SPECIFICATIONS



- DC powered (AC optional)
- Compact package
- Accepts up to 16 plug-in input cards
- Supports network communication via a 100BASE-T Ethernet connection
- Multiple units can be linked together to provide common control and synchronous sampling
- Offers user-selectable decimal-based (radix 10) and binary-based (radix 2) scanning rates
- On-board program and data storage
- Supports local diagnostics
- Supports software identification and setup of each type of plug-in card

OPERATION:
Stand-alone or direct software control.

INPUTS:
Accepts up to 16 cards (one channel per card and up to 16 channels per unit).

SYNC: Multiple scanners synchronized with synchronization cable links.

DATA STORAGE:
Can be configured:
Internal: 2GB solid state.
Removable: ATA form factor removable storage devices, solid state.

INTERFACE: Type : Ethernet
Topology : 100Base-T
Protocol : TCP/IP (HTTP)

OPERATING VIBRATION:
6G peak in all three axes. Sweep to 10Hz (solid state media).

OPERATING SHOCK:
20G peak in all three axes, 5 shocks in each axis (solid state media).

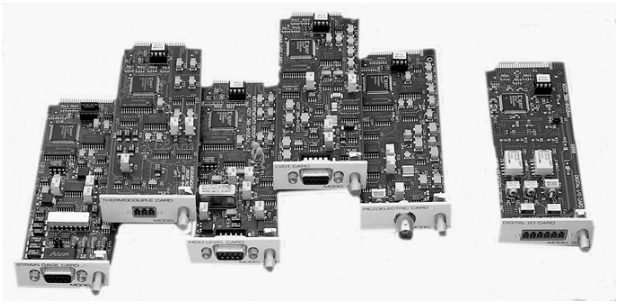
SIZE:
4 H x 10 W x 12.3 D in (102 x 254 x 312mm)

WEIGHT:
9.1lb (4.1kg) empty, 11.1lb (5.0kg) loaded with 16 plug-in cards.

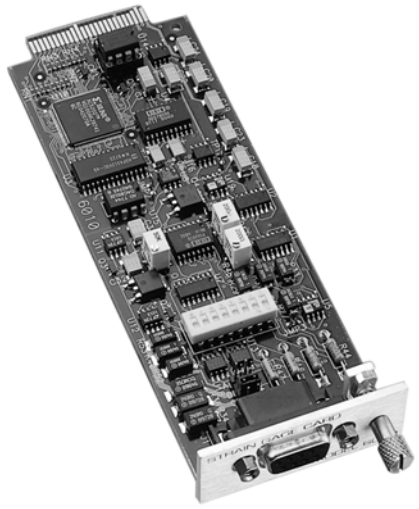
POWER:
Designed for use with dc power; 9-32Vdc, 100W max.
Optional power adapter (Model 6207); 120/240Vac.

StrainSmart® Data Acquisition System

SENSOR CARD SPECIFICATIONS



MODEL 6010A STRAIN GAGE CARD



- Supports software identification and setup of each type of plug-in card
- Complete strain gage signal conditioner with 16-bit analog-to-digital converter
- Programmable digital filter
- Programmable excitation supply per channel. The supply is settable to 0, 0.5, 1, 2, 5, and 10V. Up to 50mA of excitation current is available on each channel. Remote sense is provided for full-bridge transducers.
- Programmable gain to complement the excitation steps of 1, 2, 5, and 10V. Full-scale input range will be ±16 383με. An excitation setting of 0.5V will use the 1V gain range, but with one-half the resolution. Gain settings are independent per channel.
- Internal bridge completion resistors: 120Ω, 350Ω, and 1000Ω dummy resistors (jumper selectable); 1000 internal half bridge
- Programmable coarse balance range of ±16 300με (4096με steps)
- Fixed low-pass anti-aliasing filter (six-pole)
- Two programmable shunt calibration circuits
- Input connections to user's strain gage via nine-pin D-sub connector

CHANNELS: One per card.

INPUTS:

Strain Gages:
120Ω, 350Ω,1000Ω quarter bridges; 60Ω to 5000Ω half and full bridges.
Jumper-selectable completion resistors (0.01% ± 2.5ppm/°C typical).

Measurement Range:
Normal range mode: ±16 380με
High range mode: ±163 800με
Low range mode: ±1638με

Resolution:
Normal range mode: 0.5με
High range mode: 5με
Low range mode: 0.05με

Strain Gage Based Transducers:
60Ω to 5000Ω impedance

Measurement Range:
Normal range mode: ±8mV/V
High range mode: ±80mV/V
Low range mode: ±0.8mV/V

Resolution:
Normal range mode: 0.25μV/V
High range mode: 2.5μV/V
Low range mode: 0.025μV/V

Input Impedance:
220MΩ each input.

Source Current: ±25nA max.

Input Connector: Nine-pin D-sub style.

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AMPLIFIER:

Zero Temperature Stability:
±1.5μV/°C RTI, ±100μV/°C RTO, after 30-minute warm-up.

DC Gain Accuracy & Stability:
(±0.1% at 23°C) ±50ppm/°C

Common-Mode Rejection (dc to 60Hz):
100dB typical

Common-Mode Voltage:
±6V typical

AC Accuracy: (typical):

Input Frequency/Bandwidth:	500/3000	50/200
Spurious Free Dynamic Range:	100dB	110dB
Signal to Noise:	90dB	95dB
Signal to Distortion:	100dB	110dB

Coarse Balance Range:
±99% of measurement range (typically ±16 300με)

CALIBRATION:
Two shunt calibration points are available on each channel. Switch-selectable.
Calibration switches, A and B, are software selectable.

EXCITATION:
0.0, 0.5, 1.0, 2.0, 5.0, and 10.0Vdc. Software-programmable.

Accuracy:
±3mV typical

Current:
50mA max. Over-current protected.

Load Regulation:
<0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.005%/°C

Remote Sense:
15Ω maximum lead resistance.

A/D CONVERTER :

Type:
16-bit successive approximation with integrated sample and hold.

Integral Linearity Error:
±2 LSB

FILTERS:
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency:
User-selectable 1Hz to 4kHz

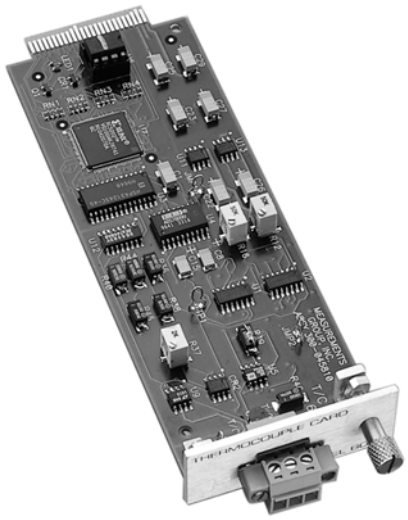
ANALOG OUTPUT: (6010A version only)

Type:
±5.00V max for typical full-scale input of ±16 380με

Output Load:
2000Ω min

Bandwidth:
DC to 15kHz (-0.5dB typical)

MODEL 6020A THERMOCOUPLE CARD



- Complete thermocouple signal conditioner with 16-bit analog-to-digital converter
- Programmable digital filter
- Programmable common cold-junction reference
- Compensation is provided for J, K, T, N, E, R, S, and B thermocouple types
- Fixed low-pass anti-aliasing filter (six-pole)
- Connections to user's thermocouple circuit via a removable three-terminal screw connector

CHANNELS: One per card.

INPUTS:
Thermocouple types J, K, T, E, N, R, S, B. Built-in electronic cold-junction compensation. Software-selectable

Open sensor detection

Input Impedance: 10MΩ differential, 100KΩ common mode.
Source Current: ±0.5nA typical; ±5nA max.

INPUT CONNECTOR: Three-position screw terminal

AMPLIFIER:

Zero Temperature Stability:
±1.5μV/°C RTI, ±100μV/°C RTO, after 30-minute warm-up.

DC Gain Accuracy & Stability:
0.05% at 23°C ± 50ppm/°C

Common-Mode Rejection (dc to 60Hz):
100dB typical

Common-ModeVoltage:
±6V typical

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AC Accuracy: (typical):

Input Frequency/Bandwidth:	500/3000	50/200
Spurious Free Dynamic Range:	100dB	110dB
Signal to Noise:	90dB	95dB
Signal to Distortion:	100dB	110dB

MEASUREMENT RANGE: ±81.9mV

RESOLUTION: 2.5μV

A/D CONVERTER :

Type:
16-bit successive approximation with integrated sample and hold.

Integral Linearity Error:
±2 LSB

FILTERS:
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency:
User-selectable 1Hz to 4kHz

MODEL 6030A HIGH-LEVEL INPUT CARD

- Complete high-level signal conditioner with 16-bit analog-to-digital converter
- Programmable gain
- Programmable digital filter
- Programmable excitation supply. The supply is settable to 0, 0.5, 1, 2, 5, 10, 15, 20, 24, and 30V. Up to 50mA of current is available on each channel.
- Fixed low-pass anti-aliasing filter (six-pole)
- Input connections to user's voltage source via nine-pin D-sub connector
- Analog output

CHANNELS: One per card.

INPUTS: DC volts (differential)

Input Impedance: 22MΩ each input.
Source Current: ±2nA typical; ±100nA max

INPUT CONNECTOR: Nine-pin D-sub style

AMPLIFIER:

Zero Temperature Stability:
±2μV/°C RTI, typical. ±100μV/°C RTO, after 30-minute warm-up.

DC Gain Accuracy & Stability:
±0.05% at 23°C ± 20ppm/°C

Common-Mode Rejection (dc to 60Hz):
86dB typical at X1 gain
94dB typical at X10 gain

Common-Mode Voltage:
±12V typical

AC Accuracy: (typical):

Input Frequency/Bandwidth:	500/3000	50/200
Spurious Free Dynamic Range:	100dB	110dB
Signal to Noise:	90dB	95dB
Signal to Distortion:	100dB	110dB

MEASUREMENT RANGES: ±1, ±2, ±5, ±10Vdc

RESOLUTION: 30.5, 61, 152.5, 305μV

EXCITATION:
0, 0.5, 1.0, 2.0, 5.0, 10.0, 15.0, 20.0, 24.0, 30.0Vdc

Accuracy:
±10mV typical at 0 to 24Vdc; ±5% at 30Vdc

Current:
50mA max. Over-current protected

Over-current protected.

Load Regulation:
<±0.05% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.005%/°C

A/D CONVERTER :

Type:
16-bit successive approximation with integrated sample and hold.

Integral Linearity Error:
±2 LSB

FILTERS:
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency:
User-selectable 1Hz to 4kHz

ANALOG OUTPUT: (6030A version only)

Type:
±5.00V max for typical full-scale input of ±32767με

Output Load:
2000Ω min

Bandwidth:
DC to 15kHz (-0.5dB typical)

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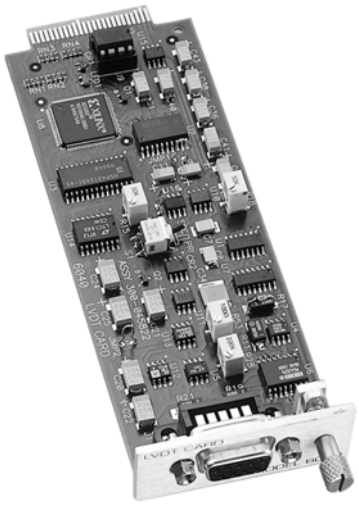
MODEL 6040A LVDT CARD



- Complete LVDT signal conditioner with 16-bit analog-to-digital converter
- Programmable digital filter
- Independent ac excitation supply
- Programmable gain steps of 1, 2, 5, and 10
- Supports six-, five-, four-, and three-wire transducers
- Fixed low-pass anti-aliasing filter (six-pole)
- Excitation reference provided for calibration
- Input connections to user's transducer via nine-pin D-sub connector

CHANNELS: One per card.

INPUTS: 3- to 6-wire transducers.

Input Impedance: 10MΩ each input.
Source Current: ±2nA typical; ±100nA max

INPUT CONNECTOR: Nine-pin D-sub style

AMPLIFIER:

Zero Temperature Stability:
±2μV/°C RTI, typical. ±100μV/°C RTO, after 30-minute warm-up.

Gain Accuracy & Stability:
±0.25% typical

Common-Mode Rejection (dc to 60Hz):
86dB typical at X1 gain
94dB typical at X10 gain

Common-Mode Voltage:
±12V typical

MEASUREMENT RANGES: ±0.5, ±1, ±2.5, ±5Vrms

RESOLUTION: 15.25, 30.5, 76.2, 152.5μVrms

CALIBRATION: Excitation sample

EXCITATION:
3.0Vrms at 2500, 5000, or 10000Hz sine wave.
Software-selectable

Accuracy:
±5mVrms typical

Current:
±50mA max.
Over-current protected.

Load Regulation:
<±0.1% of full scale for a load variation of 10% to 100% of full load

Temperature Stability:
Better than ±0.05%/°C

A/D CONVERTER :

Type:
16-bit successive approximation with integrated sample and hold

Integral Linearity Error:
±2 LSB

FILTERS:
Butterworth, six-pole anti-aliasing analog filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency:
User-selectable 1Hz to 4kHz

ANALOG OUTPUT: (6040A version only)

Linear Output: ± 5.00V for typical full-scale input

Output Load: 2000Ω min

Bandwidth: DC to 1kHz (-3dB typical)

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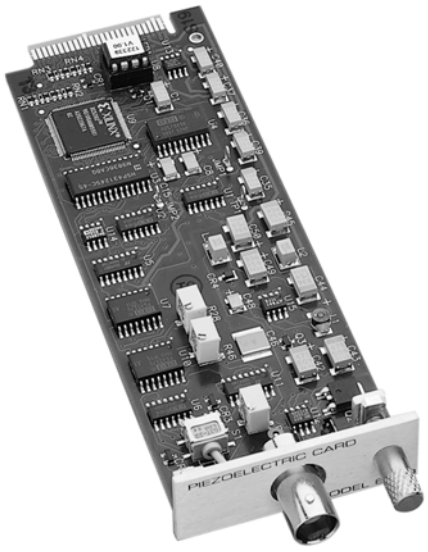
MODEL 6050 PIEZOELECTRIC CARD



- Complete piezoelectric signal conditioner with 16-bit analog-to-digital converter
- Supports both VM (voltage mode, low impedance) and CM (charge mode, high impedance) type piezoelectric transducers
- Programmable constant current excitation supply for VM transducers is software settable to 1, 2, 4, 5, 10 and 20mA
- Programmable gain steps of 1, 2, 5, and 10 for VM transducers and steps of 1, 2, 5, 10, 20, 50 and 100 for CM transducers
- Programmable digital filter
- Fixed low-pass anti-aliasing filter (six-pole)
- Input connections to user's transducer via BNC connector

CHANNELS: One per card.

INPUTS: Voltage mode (VM) or charge mode (CM) piezoelectric type transducers (type is switch-selectable)

Coupling:
CM type - charge amplifier with software-selectable time constants of 0.5 and 5 seconds
VM type - ac coupling to remove dc bias voltage with high pass response of 0.1Hz (-3dB)

INPUT CONNECTOR: Female BNC

AMPLIFIER:

Zero Temperature Stability:
±10μV/°C RTI, typical, after 30-minute warm-up

Charge Amplifier Zero Stability:
±1.2pC/°C RTI typical at 0.5 second time constant

DC Gain Accuracy & Stability:
±0.1% at +23°C; ±25ppm/°C

AC Accuracy: (typical at X2 gain step)

Input Frequency/Bandwidth:	500/3000	50/200
Spurious Free Dynamic Range:	100dB	110dB
Signal to Noise:	90dB	95dB
Signal to Distortion:	100dB	110dB

MEASUREMENT RANGES:
VM type transducers: ±10.5V, ±5.25V, ±2.1V, and ±1.05V
CM type transducers: ±200 000pC, ±100 000pC, ±40 000pC, ±20 000pC, ±10 000pC, ±4000pC, and ±2000pC

RESOLUTION: 0.0015% of range

CALIBRATION: Excitation sample

EXCITATION:
0, 1, 2, 4, 5, 10 and 20mA selections for VM type transducers

Accuracy:
±1% + (±30μA) typical at 1 to 20mA

Voltage Compliance: 0 to 28V.

Temperature Stability:
±50ppm/°C

A/D CONVERTER :

Type:
16-bit successive approximation with integrated sample and hold

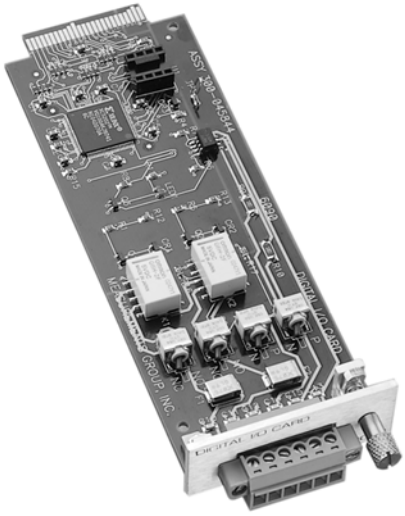
Integral Linearity Error:
±2 LSB

FILTERS:
Linear phase, analog, 6-pole anti-aliasing filter, and 256-tap, programmable, FIR digital filter (lowpass)

Passband Frequency:
User-selectable 1Hz to 4kHz

StrainSmart® Data Acquisition System

MODEL 6095 DIGITAL/TACHOMETER CARD



- Multi-function digital input card
- Relay output for control functions
- Compatible with all System 6000 hardware
- Supported by StrainSmart software

When used in conjunction with Vishay Micro-Measurements StrainSmart® Software, the Model 6095 Digital/Tachometer Card enables the user to capture and reduce data in any one of five operating modes:

- Tachometer Mode
- Interval Mode
- Quadrature Mode
- Counter Mode
- Digital Input Mode

Depending upon the mode selected, data can be reduced as a digital input; counts; interval counts; pulses; rate; shaft angle; RPM; radians or degrees per second; elapsed time (milliseconds, seconds or minutes); or calculated values.

Multiple Model 6095 Cards can be used in each system, and each card in a system can be configured individually to any operating mode. However, the relay provides one distinct control function (on/off control for testing machines, etc.) per system when using a Model 6100 Scanner, or one per scanner when using multiple Model 6200 Scanners.

The Model 6095 is compatible with all Model 6100 and 6200 Scanners. It is supported by Version 3.0, and later, StrainSmart Software; no-charge upgrades are available upon request.

INPUT CONNECTOR: Nine-pin, D-sub style

RELAY OUTPUTS:

Quantity: One

Configuration: NO and NC, 500mA contact at 30Vac or 30Vdc into resistive load.

DIGITAL INPUTS:

Quantity: Four

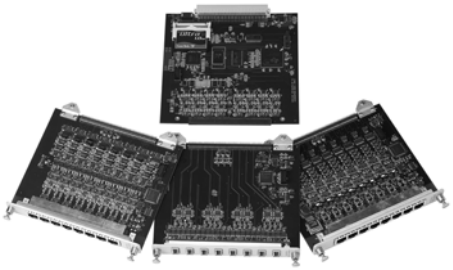
Configuration: Optically isolated. TTL Schmitt-trigger input thresholds accept up to 28Vdc without damage. 2.23Ω pull-up resistors can be selected for each input.

Impedance: 50kΩ

Data Rate: DC to 200kHz

Accessory Supply: 5 Volt ± 5%, 75mA

StrainSmart® Data Acquisition System



FEATURES

- Stable, accurate, low-noise signal conditioning
- Measurement accuracy ±0.05%
- Measurement resolution 0.5 microstrain
- Individual input cards for strain gage and strain-gage-based transducers (Model 7003-8-SG), thermocouples (Model 7003-8-TC), and sensors with high-level voltage outputs (Model 7003-8-HL)
- Electronically selectable, built-in bridge completion for 120-, 350-, and 1000-ohm strain gages
- Virtually unlimited number of channels in increments of 8 channels
- Maximum scan rate of 2048 samples per second
- Self calibration traceable to NIST standard
- Simultaneous sampling with anti-aliasing filter and analog-to-digital conversion for each channel
- Selectable digital filtering of measurement signals
- High-speed Ethernet network interface

DESCRIPTION

Vishay Micro-Measurements System 7000 builds upon the years of experience gained since the introduction of Systems 4000, 5000, and 6000 by continuing to provide a complete hardware/software approach to data acquisition, reduction, and presentation for strain gages and related sensors for stress analysis testing.

System 7000 hardware is designed to incorporate all the features required for precision strain measurement in a high channel density enclosure. Strain gages, strain-gage-based transducers, thermocouples, and other sensors with high level voltage outputs can be intermixed in groups of eight (8) by choosing the appropriate sensor card for up to 128 channels in a 4U height, 19-inch rack-mountable scanner (7000-128-SM). The Ethernet interface allows flexible positioning of scanners, and multiple scanners can easily be synchronized using a single sync cable (maximum length 100 meters). A system can be configured with virtually an unlimited number of sensors.

System 7000 is a high performance data acquisition instrument with measurement accuracy of ±0.05% of full scale. Each sensor card employs a 24-bit analog to digital converter enabling 0.5 microstrain resolution. Scan rates up to 2048 samples per second are available for simultaneous reading of all sensor inputs. A combination of analog and flexible Finite Impulse Response (FIR) filters are available to provide adequate anti-alias filtering at all scanning rates. Each sensor card has high-capacity nonvolatile data storage capability. Electronically selectable bridge completion resistors allow the user to choose between 120-, 350-, and 1000-ohm strain gages through software selection.

Several design features are provided to reduce total cost of ownership. System 7000 is capable of self-calibration with a removable calibration reference (7000-SM-VC). Calibration can be performed anywhere and there is no need to return the entire system to the factory for calibration. Down-time while waiting for calibration is essentially eliminated. Input connectors are RJ-45 type and assembly time is fast using simple cable crimping tools. Sensor input cards all use common Analog Input Cards (Model 7003-8-A-I), which thereby allow users to interchange sensor input cards with analog input cards. Individual scanners can be separated and located near sensors to reduce sensor cabling costs.

StrainSmart® Data Acquisition System

MODEL 7000-128-SM SCANNER SPECIFICATIONS

The purpose of the Model 7000-128-SM Scanner is to house and retain the acquisition cards, regulate power to the cards, establish and maintain communication between the Ethernet interface and the input cards, synchronize the analog-to-digital converters in the system, and provide visual status information to the operator.

CAPACITY:
Up to 16 Input Cards. 128 channels maximum

CONFIGURATIONS:
Rack-mount (19-inch) or bench-top

LCD DISPLAY:
64 x 128 white LED-backlit display

LED PANEL:
128 individual red/green LEDs; one per channel

KEYPAD:
Membrane. 20-key; 12 key numeric keypad, 5 key navigation keypad, and three soft-keys

INPUT POWER:
10 - 32Vdc, 30A max

POWER INDICATION:
Green LED. Illuminated when power is on

ETHERNET INTERFACE:
IEEE 802.3, 802.3u 10Base-T, 100Base-TX, half- and full-duplex, auto-detect

COMPACT FLASH® CAPACITY:
512MB supplied; 2GB maximum, Removable

PROCESSOR:
250MHz floating point digital signal processor

MEMORY:
64MB SDRAM

INTERNAL COMMUNICATION:
Asynchronous command bus, synchronous data bus

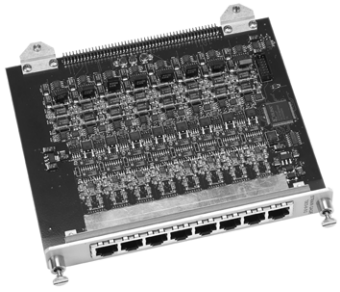
SYSTEM SYNCHRONIZATION:
Connections: Sync In, Sync Out
Topology: Daisy-chain
Cable Connection: TIA/EIA RJ-45, Category 5
Max. Distance: 100m

SYSTEM CALIBRATION REFERENCE:
Firmware-controlled
Accuracy: ±40ppm of setting
Drift: 1.9ppm/°C ± 0.6µV/°C typical, 9.4ppm/°C ± 2.1µV/°C maximum
Resolution: 150µV nominal
Voltage Range: ±5V

DIMENSIONS:
7 H x 17.5 W x 13.37 D inches (178 x 445 x 340mm)

WEIGHT:
20lb (9.1kg)

MODEL 7003-8-SG STRAIN GAGE INPUT CARD



The Model 7003-8-SG Strain Gage Input Card is used in conjunction with the Model 7003-8-A-I Analog Input Card to perform bridge excitation, bridge completion, shunt calibration, and signal conditioning for eight quarter, half, and full bridges.

CHANNELS:
Eight per card

INPUTS:
Software selectable for S+/S-, Vcal+/Vcal-, or excitation
Strain Gage: 120Ω, 350Ω, 1000Ω quarter-bridges; 60Ω to 5000Ω half- and full-bridges
Input Impedance: 220MΩ nominal each input
Source Current: ±5nA per volt excitation

MEASUREMENT RANGE AND RESOLUTION:
Total range depends upon excitation setting (see table).
Resolution: 0.5µε (GF=2)

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Excitation Volts	Measuring Range Includes Full Scale Imbalance	
	με@GF=2	mV/V
0	48 000	24
0.25	100 000	50
0.5	96 000	48
0.75	70 000	35
1	48 000	24
2	24 000	12
3	16 000	8
4	50 000	25
5	40 000	20
6	35 000	17.5
7	30 000	15
8	25 000	12.5
9	20 000	10
10	20 000	10

INPUT CONNECTOR:
Eight-pin TIA/EIA RJ-45 (Amp type 554739 or equivalent)

AMPLIFIER:
Zero Temperature Stability: ±1μV/°C RTI, after 60-minute warm-up
DC Gain Accuracy and Stability: ±0.05%; ±50ppm/°C (1 year without periodic VCAL)
Analog Input (including full-scale balance):
Low Range: ±50mV
High Range: ±220mV
Linearity: ±0.02% of Full Scale
Common-Mode Rejection: >90dB (dc to 60Hz)
Common-Mode Voltage Range: ±12V typical

BALANCE:
Type: Software (mathematical)
Range: Full ADC Range

EXCITATION:
Selection: Software controlled
Resolution: 1mV
Accuracy: ±4mV typical (Firmware measures excitation variations during arming process)
Current: 50mA max. per channel
Over-current limited
Over-current indication
Load Regulation: <0.05% of full scale for 10% to 100% of full scale load with remote sense
Temperature Stability: ±10ppm/°C

QUARTER-BRIDGE COMPLETION:
Selection: Firmware-controlled
Accuracy and drift:
120Ω and 350Ω: ±0.01%, 2.8ppm/°C max.
1kΩ: ±0.01%, 1.6ppm/°C max. (socketed)

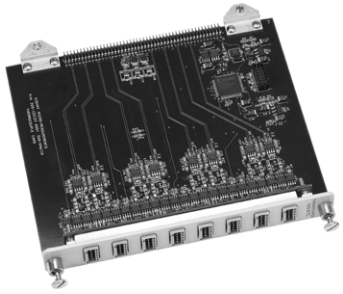
SHUNT CALIBRATION:
Selection: Firmware-controlled
Configuration:
Internal: P- to D120, P- to D350, P- to D1000
Remote: RcalA to RcalB
Sockets: Tin-plated
Levels: Simulates 10000με @GF = 2.0
Values:
P- to D120: 5940Ω ±0.1%
P- to D350: 17325Ω ±0.1%
P- to D1000: 49500Ω ±0.1%

SYSTEM CALIBRATION:
Firmware-controlled
Calibration voltage: Supplied by Model 7000-SM-VC voltage calibration card
Type: Ten point, 100 samples/point. Least squares regression of mean values

SIZE:
6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23mm)

WEIGHT:
0.45lb (0.2kg)

MODEL 7003-8-TC THERMOCOUPLE INPUT CARD



The Model 7003-8-TC Thermocouple Input Card is used in conjunction with the Model 7003-8-A-I Analog Input Card to perform signal conditioning and cold-junction compensation for thermocouple types J, K, T, E, N, R, S, and B.

CHANNELS:
Eight per card

INPUTS:
Supported thermocouple types: J, K, T, E, N, R, S, B
Cold-junction compensation, software-selectable
Open-sensor detection
Input Impedance: 220MΩ nominal each input
Input Connectors:
Five-position connector with screw terminals

AMPLIFIER:
Zero Temperature Stability: ±2μV/°C RTI, ±10μV/°C RTO, after 60-minute warm-up
DC Gain Accuracy and Stability: ±0.1%; ±30ppm /°C
Linearity: ±0.02% of Full Scale
Common Mode Rejection (dc to 60Hz): >90dB
Common Mode Voltage range: ±12V typical

MEASUREMENT RANGE AND RESOLUTION:
Range: ±81.9mV
Resolution: 1°C minimum

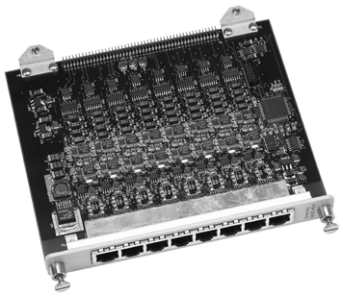
ACCURACY:
±2°C

SIZE:
6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23mm)

WEIGHT:
0.45lb (0.2kg)

StrainSmart® Data Acquisition System

MODEL 7003-8-HL HIGH LEVEL INPUT CARD



The Model 7003-8-HL High Level Input Card used in conjunction with the Model 7003-8-A-I Analog Input Card to perform signal conditioning and excitation for high level (±10V) inputs.

CHANNELS:
Eight per card

INPUTS:
Differential
Input Impedance: 220MΩ nominal each input
Input Bias Current: ±0.5nA typical (±2nA max.)

INPUT CONNECTOR:
Eight-pin RJ-45

AMPLIFIER:
Zero Temperature Stability: ±2µV/°C RTI, typical, ±10µV/°C RTO, after 60-minute warm-up
DC Gain Accuracy and Stability: ±0.1%; ±30ppm /°C
Linearity: ±0.02% of Full Scale
Common-Mode Rejection (dc to 60 Hz): >90dB
Common-Mode Voltage Range: ±12V typical

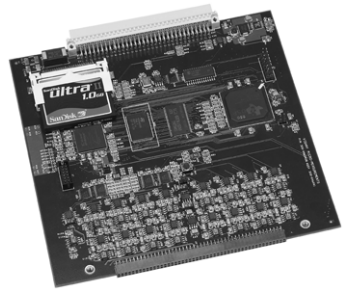
MEASUREMENT RANGES AND RESOLUTION:
Range: ±10V
Resolution: 100µV effective

EXCITATION:
Selection: Software controlled
Bipolar range: 0 to ±15Vdc (30Vdc total)
Unipolar range: 0 to +24Vdc
Accuracy: ±0.1% of full scale using remote sense
Current: 100mA max. Over-current/over-temperature protected
Load Regulation: <0.05% of full scale (bipolar mode) for a load variation of 10% to 100% of full scale load (with remote sense)
Temperature Stability: Better than ±30ppm/°C

DIMENSIONS:
6.5 L x 6.5 W x 0.9 H in (165 x 165 x 23mm)

WEIGHT:
0.45lb (0.2kg)

MODEL 7003-8-A-I ANALOG INPUT CARD



The Model 7003-8-A-I Analog Input Card performs the analog anti-alias filtering, analog-to-digital conversion and data storage for the System. The Model 7003-8-A-I is used in conjunction with a Sensor Input Card, which performs the sensor-specific analog conditioning.

The Model 7003-8-A-I consists of eight dedicated 3-pole constant delay analog anti-alias filters, eight fully synchronized, 24 bit analog-to-digital converters operating at 40k samples/second/channel, a dedicated digital signal processor to perform scaling and digital filtering, an 800,000 sample pre-trigger buffer, and 512MB of CompactFlash® memory for data storage.

CHANNELS:
Eight per card

A/D CONVERTER:
Quantity: Eight (one per channel)
Architecture: Sigma-delta
Resolution: 24 bits
Conversion Rate:
Radix-10: 40k samples/second/channel
Radix-2: 40.96k samples/second/channel

DATA RECORDING RATES:
2048, 1024, 512, 256, 128, or 64 samples/second/channel (radix-2)
2000, 1000, 500, 200, 100, or 10 samples/second/channel (radix-10)

PRE-TRIGGER BUFFER:
Type: SDRAM, firmware-controlled
Depth: 800,000 samples/channel

ANALOG ANTI-ALIAS FILTER:
Type: Low-pass
Frequency: 3.5kHz @-3dB
Number of Poles: Three
Topology: GIC, constant delay

PROCESSOR:
Type: 32-bit floating point digital signal processor
250MHz operating frequency

RAM:
Type: SDRAM
Size: 64MB

PROGRAM AND CALIBRATION DATA STORAGE:
Type: Flash Memory
Size: 1MB

DATA STORAGE:
Type: Sandisk Ultra-Series II® CompactFlash
Quantity: One per card
Capacity: 512MB supplied; 2GB maximum
Removable

DIGITAL-TO ANALOG CONVERTER:
Resolution: 24 bit
Range: 0-10V

SIZE:
6.8 L x 6.5 W x 0.7 H in (173 x 165 x 18mm)

WEIGHT: 0.35lb (0.16kg)

Special Purpose Instruments

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Gage Installation Tester

FEATURES

- A compact, battery-powered instrument used to verify the electrical quality of a strain gage installation BEFORE it is placed in service
- Reads with the push of a button—no warm-up
- Reads insulation resistance (leakage) to 20 000 megohms with 15Vdc
- Measures deviation of installed gage resistance from precise standards to a resolution of 0.02 percent
- Ohmmeter scale for troubleshooting questionable installations
- Verifies the complete gage circuit, including leadwires

DESCRIPTION

Two of the most important measurements used to verify the quality of a strain gage installation are insulation resistance (leakage to ground) and shift in gage resistance due to installation procedures. While these two measurements are not a complete guarantee of eventual proper strain gage performance, any installation that produces questionable values should not be relied upon where accuracy of results is necessary.

For example, a voltage difference between the specimen and strain gage frequently exists. A low insulation resistance will permit this voltage differential to introduce extraneous signals during strain measurement.

Several sources of variations in insulation resistance and shifts in gage resistance are:

- Insulation resistance in excess of 20 000 megohms should be expected for foil strain gages when installed under laboratory conditions. A value of 10 000 megohms should be considered minimum. A reading below this value generally indicates trapped foreign matter, moisture, residual flux or backing damage due to soldering, as well as incomplete solvent evaporation from an overcoating.
- Deterioration of the insulation resistance with time may be an indication of an improperly coated installation.
- At higher test temperatures, particularly above +300°F [+150°C], it is normal to expect lesser values. Ten megohms is considered to be the lower allowable value.
- Shifts in gage resistance during installation should not normally exceed 0.5% when using room-temperature-curing adhesives. Resistance shifts greater than 0.5% generally indicate damage to the gage due to improper handling or clamping. However, strain gages installed using elevated-temperature-curing adhesives may exhibit greater shifts in resistance due to adhesive lock-up at elevated temperatures (difference in linear coefficient of thermal expansion between the strain gage and specimen). These shifts will vary depending upon the specific cure temperature and materials used. The shifts should never exceed 2% and should be uniform within 0.5%.

Gage Installation Tester

SPECIFICATIONS

Input Circuits:
Gages: Three-wire quarter bridge (120Ω and 350Ω) and half bridge. Other value quarter bridges using customer's reference, at readily accessible panel terminals.
As ohmmeter: Two leads (500Ω and 500MΩ midscale).

Input Leads:
4-ft [1.2m] 4-conductor AWG #26 [0.4-mm diameter] twisted Teflon®-insulated cable supplied (with ground clip and three tinned leads).

Meter:
3.5-in size (3.00-in [76-mm] scale length) with mirror. Tracking accuracy ±1% full range.

Mode Switch:
Five momentary push buttons: battery check, ±5% deviation, ±1% deviation, gage resistance (ohms), and insulation resistance (megohms).

Deviation Mode:
Two ranges, ±1% and ±5%, F.S. (50 graduations either side of zero).
Accuracy:
1% range: 0.04% ΔR (2 meter graduations)
5% range: 0.2% ΔR (2 meter graduations)
Excitation: 1.0Vdc per gage.

Insulation Resistance Mode:
Graduated 5MΩ to 20 000MΩ (500MΩ mid-scale).
Accuracy: 1 scale division.
Test Voltage: 15Vdc open circuit.

Ohm Mode:
Graduated 5Ω to 20kΩ (500Ω mid-scale).
Accuracy: 1 scale division.
Test Voltage: 2Vdc open circuit (0.4Vdc @120Ω).

Environmental:
+15° to +125°F [–10° to +50°C]; up to 80% relative humidity, non-condensing.

Size:
Aluminum case (separable lid) 5 H x 7 W x 5 D in with lid [125 x 180 x 126mm].

Weight:
3.6lb [1.6kg] with batteries.

Power Supply:
Four 9V NEDA 1604 batteries (Eveready® 216 or equivalent).
Life: Will fully test 1000-5000 installations.

All specifications are nominal or typical @ +23°C unless noted.

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Eveready is a Registered Trademark of Eveready Battery Co Inc.

Strain Indicator Calibrator

A laboratory standard for verifying the calibration of strain and transducer indicators.

FEATURES

- True Wheatstone bridge circuitry
- Simulates quarter, half &full bridge - both 120Ω/350Ω
- Three decades of push buttons
- Strain range direct reading: ±99 900με. . . increments of 100με
- Transducer range: ±49.95mV/V. . . increments of 0.05mV/V
- Reversing switch for plus and minus calibration
- High precision Vishay resistors used throughout to ensure excellent stability
- Accuracy 0.025 percent - traceable to the U.S. National Institute of Standards and Technology

DESCRIPTION

Sound engineering and laboratory practices require that the instrumentation used to make critical strain measurements be periodically calibrated to verify that it is within the manufacturer's original specifications. Additionally, each type of strain indicator exhibits some degree of nonlinearity, especially for large strains during quarter-bridge operation. Since this is the most common stress analysis application of strain gages, it is important that the strain indicator be calibrated in this mode. Instrumentation span should also be checked at a number of points before each important test to avoid inaccurate data.

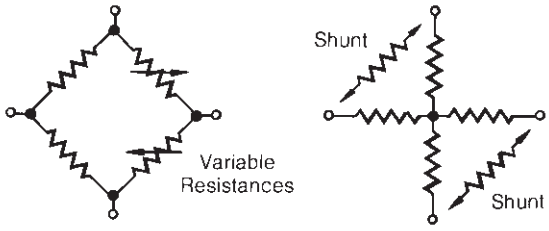
The Model 1550A calibrator is a Wheatstone bridge and generates a true change of resistance in one or two arms of the bridge. It simulates the actual behavior of a strain gage in both positive and negative strain.

The 'star network' used in certain other commercial calibrators provides a substantially lower cost instrument design, because component specifications are less critical, and fewer components are required.

However, the 'star network' cannot simulate quarter-bridge strain gage behavior, and cannot simulate positive strain. Another serious problem with this circuit is that the bridge input and output resistances change in an abnormal manner, leading to inaccuracies in calibration under some conditions.

A calibrator based on the Wheatstone bridge principle requires stable components. A total of 66 ultra-stable Vishay precision resistors are used in the Model 1550A calibrator to provide the stability, repeatability, accuracy and incremental steps required in a laboratory standards instrument.

WHEATSTONE BRIDGE / STAR NETWORK



Strain Indicator Calibrator

A certificate of calibration is provided with each Model 1550A calibrator

SPECIFICATIONS

Accuracy:
0.025% of setting ±1με (0.0005mV/V), maximum.
Traceable to United States National Institute of Standards and Technology.

Repeatability:
±1με (0.0005mV/V), maximum

Stability:
(0.001% of setting ±1με)/°C, maximum

Thermal EMF:
0.5μV/V of excitation, maximum

Bridge Resistances:
120Ω and 350Ω

Input Resistance:
±0.05%, maximum, from nominal at all output settings.

Output Resistance:
±0.05%, maximum, from nominal at "000"με,
-0.25% at ±99 900με.

Circuit:
True ±ΔR in two adjacent arms (opposite signs), plus two fixed arms for bridge completion.

Simulation:
Quarter bridge, one active arm.
Half bridge, one or two active arms.
Full bridge, two active arms.

Range:

Two active arms:
0 to ±99 900με in steps of 100με @GF = 2.00.
0 to ±49.95mV/V in steps of 0.05mV/V.

One active arm:
0 to ±49 950με in steps of 50με @ GF = 2.00.

Excitation:

To meet accuracy and repeatability specifications:
120Ω: up to 10Vdc.
350Ω: up to 15Vdc.

Maximum Permissible:
120Ω: 25V ac or dc.
350Ω: 30V ac or dc.

Output @ 000:
50με (0.025mV/V), maximum in full-bridge mode.

Environment:
Temperature: +50° to +100°F (+10° to +38°C).
Humidity: up to 70% RH, non-condensing.

Size:
Aluminum case (separable lid):
5-3/4 H x 8-1/4 W x 7-3/4 D in (145 x 210 x 195mm).

Weight:
4.8lb (2.2kg).

All specifications are nominal or typical at +23°C unless noted.

Model V/E-40

Vishay Micro-Measurements

Strain Gage Simulator

FEATURES

- 5 Decade selector switches
- Resistance range: 30.00 to 1111.10Ω in 0.01Ω steps
- High precision Vishay resistors used throughout to ensure excellent stability
- Accuracy 0.02% of setting
- Simulates tension and compression strain for most widely used strain gage resistance values
- Simulates a broad range of RTD's for instrumentation setup and calibration

A precision decade resistor for accurately simulating the behavior of strain gages and RTD's.

DESCRIPTION

The V/E-40 Strain Gage Simulator is an accurate, stable, compact, five-decade resistor specially designed to simulate the behavior of strain gages and RTD's, and for use in a broad range of measurement and calibration applications.

As a precision strain gage simulator, the V/E-40 can be used to measure nonlinearity of the instrumentation in quarter-bridge operation, or to verify instrument calibration over the anticipated measurement range. It is also well suited to measuring desensitization of the strain gage circuit due to the finite resistance of the strain gage leadwire system.

In a similar manner, the V/E-40 can be temporarily substituted for an RTD over a resistance range of 30.00 to 1111.10 ohms to verify calibration of temperature measurement instrumentation.

The V/E-40 can also be used in conjunction with a conventional Wheatstone bridge strain indicator to measure arbitrary resistances between 30.00 and 1111.10 ohms, or to eliminate Wheatstone bridge nonlinearity effects when measuring high post-yield strains in quarter-bridge operation. In this mode, the resistance or strain gage to be measured is connected as one arm of a Wheatstone bridge, the V/E-40 is used as a decade resistor in an adjacent arm, and the strain measuring instrument as a null detector.

Other applications include use as an investigative tool to troubleshoot faulty strain gage installations, or as a precision decade resistor.

SPECIFICATIONS

Accuracy:
0.02% of reading.

Maximum Current:
(To meet accuracy and repeatability specifications:)
120Ω: 65mA; **350Ω**: 55mA; **1000Ω:** 25mA.

Stability:
±3ppm/°C maximum.

Resistance range:
30.00 to 1111.10Ω in 0.01Ω steps.

Environment:
0° to +120°F [–18° to +49°C], up to 70% relative humidity, non-condensing.

Size:
3-7/8 H x 9-1/8 W x 3-1/8 D in [98 x 232 x 89mm].

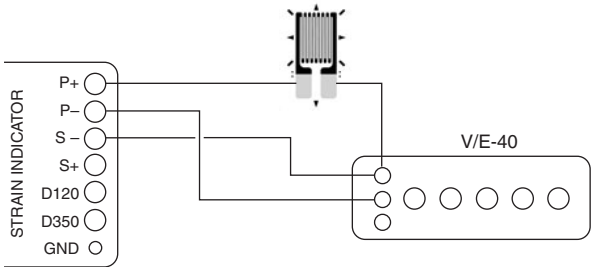
Weight:
1.9lb [0.85kg].

All specifications are nominal or typical at +23°C [+73°F]

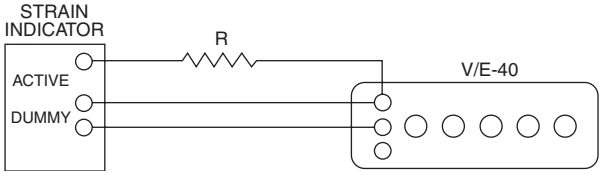
Strain Gage Simulator

APPLICATIONS

In use with Model 3800 Wide Range Strain Indicator



V/E-40 used for large strain measurement



V/E-40 used to measure arbitrary resistance value, R

Portable Strain Gage Welding and Soldering Unit

FEATURES

- Separate visual and audible indicators monitor welder status — Weld energy is continuously adjustable from 3 to 50 joules, making the Model 700 an excellent choice for installing weldable strain gages and temperature sensors, as well as small thermocouples and light-gauge metal.
- Supplied with a lightweight soldering pencil — A front-panel control adjusts soldering tip temperature for a wide range of soldering applications in the field or in the laboratory.
- "Low-battery" light to warn the user when the internal, sealed lead-acid battery requires charging — A battery charger is included to provide for full battery charge with no danger of overcharging. Indicator lights monitor battery charge rate.
- Convenient storage space for cables, battery charger and instruction manual.

GENERAL SPECIFICATIONS

Overall Size:
9 L x 9 W x 9-3/4 H in [230 x 230 x 250mm].

Weight:
21lb [9.5kg].

Power for Recharging:
115Vac or 230Vac, 50-60Hz. Uses external AC transformer (provided).

Operating and Storage Temperature Range:
0° to +120°F [–20° to +50°C].

WELDING SPECIFICATIONS

Weld Energy Range:
3 to 50 joules, continuously adjustable by front-panel control. Maximum open-circuit voltage less than 25Vdc.

Maximum Weld Repetition Rate:
20 per minute at 30 joules, typical.

Number of Welds per Battery Charge:
Approximately 2000 at weld energy setting of 30 joules. This is equivalent to 40 Micro-Measurements weldable gage installations.

Battery Charge Time: (from full discharge)
12 hours to 75% full charge; 18 hours to full charge.

Battery:
One sealed, rechargeable lead-acid (non-liquid) type, 12 volt, 5 ampere-hour.

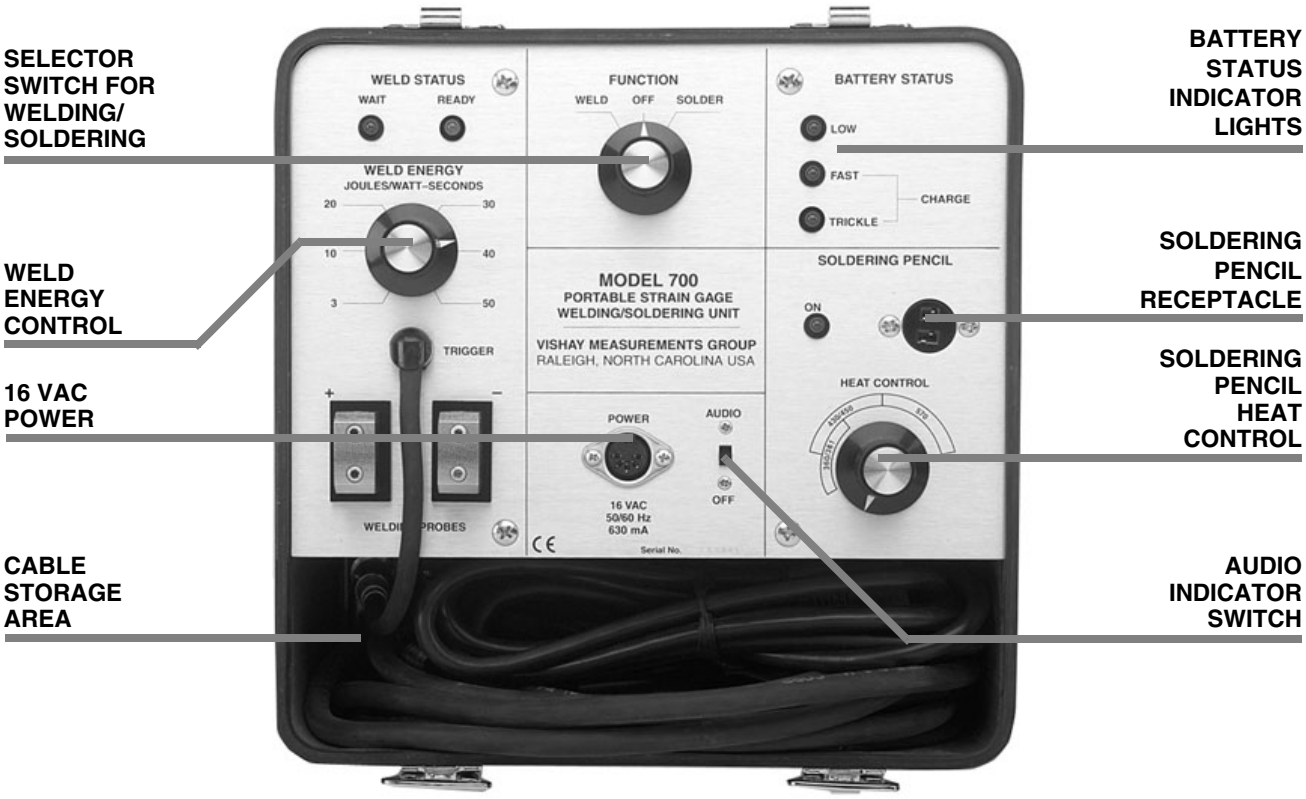
Welding Probe:
Manually fired with trigger control and "steady-rest."

Welding Cables:
Two 5 ft [1.5m], fully flexible.

Weld Energy Monitor:
Calibrated front-panel control with READY and WAIT indicators; audible indication selectable.

Portable Strain Gage Welding and Soldering Unit

PANEL CONTROL FEATURES



SOLDERING SPECIFICATIONS

Temperature Control:
Continuously variable with bands indicating melting range of solders.

Soldering Pencil:
1.1 oz [31 gm], rated at 25 watts, 12 volt operation. Tip temperature adjustable from +200° to +900°F [+90° to +480°C].

Soldering Duration:
4 hours using +361°F [+183°C] melting point solders (with initial full charge).

Accessory:
Model 700-A103 Spot Welding Probe Set:
Recommended for spot welding instrument leadwires to ZC-Series high-temperature gage ribbons.

All specifications are nominal or typical at +23°C unless noted.

Milling Guide
for Residual Stress Measurements

INTRODUCTION

A predominant factor contributing to the structural failure of machine parts, pressure vessels, framed structures, etc., may be the residual "locked-in" stresses that exist in the object prior to its being put into service. These residual stresses are usually introduced during manufacturing, and are caused by processes such as casting, welding, machining, heat treating, molding, etc.

Residual stress cannot be detected or evaluated by conventional surface measurement techniques, since the strain sensor (strain gage, photoelastic coating, etc.) can only respond to strain changes that occur after the sensor is installed.

The most widely used practical technique for measuring residual stresses is the hole-drilling strain gage method described in ASTM Standard E837. With this method, a specially configured electrical resistance strain gage rosette is bonded to the surface of the test object, and a small shallow hole is drilled through the center of the rosette. The local changes in strain due to introduction of the hole are measured, and the relaxed residual stresses are computed from these measurements. Vishay Micro-Measurements Tech Note TN-503, *Measurement of Residual Stresses By The Hole-Drilling Strain Gage Method*, presents a detailed discussion of the theory and application of this technique.

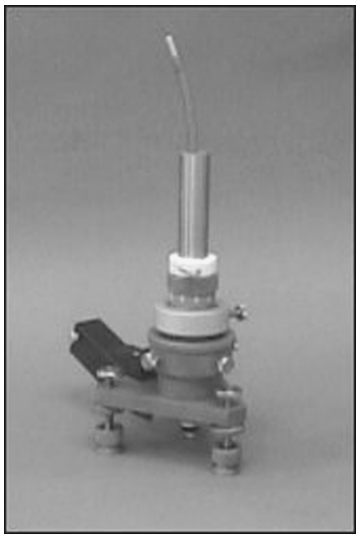
The hole-drilling method is generally considered semi-destructive, since the drilled hole may not noticeably impair the structural integrity of the part being tested. Depending on the type of rosette gage used, the drilled hole is typically 0.062 or 0.125in (about 1.5 or 3.0mm), both in diameter and depth. In many instances, the hole can also be plugged, if necessary, to return the part to service after the residual stresses have been determined.

The practicality and accuracy of this method is directly related to the precision with which the hole is drilled through the center of the strain gage rosette. The Vishay Micro-Measurements RS-200 milling guide provides a practical means to accomplish this task.

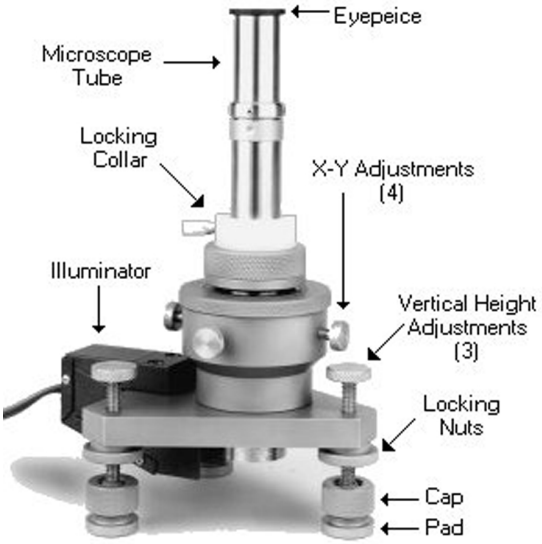
RS-200 MILLING GUIDE

The RS-200 Milling Guide is a precision fixture for accurate positioning and drilling of a hole through the center of a special strain gage rosette. Principal features and components of the milling guide assembly are shown in the photos below. When installed on the workpiece, the guide is supported by three leveling screws footed with swivel mounting pads to facilitate attachment to uneven surfaces.

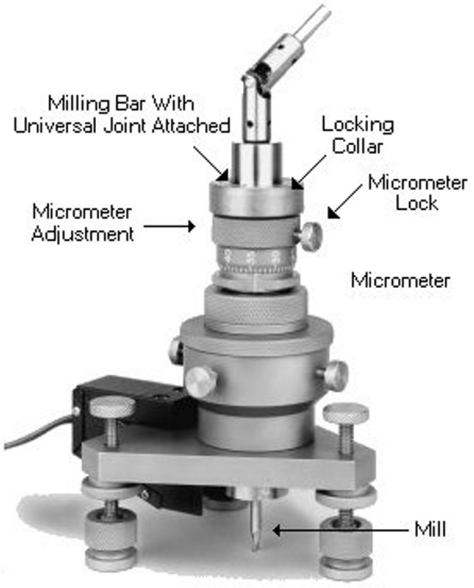
Alignment of the milling guide relative to the strain gage rosette is accomplished by inserting a special-purpose microscope into the guide's centering journal, and then positioning the guide precisely over the center of the rosette by means of four X-Y adjusting screws. The microscope assembly, consisting of a polished steel housing with eyepiece, reticle, and objective lens, permits alignment to within 0.0015in (0.038mm) of the gage center. The microscope is also used to measure the diameter of the hole after it is drilled. An illuminator attaches to the base of the guide to aid in the optical alignment procedure.



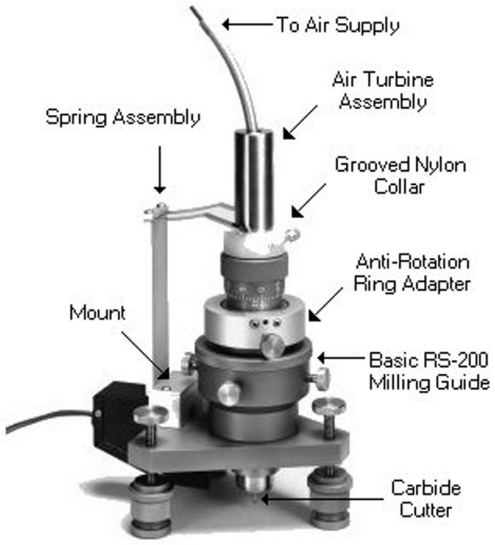
Milling Guide
for Residual Stress Measurements



After alignment, the microscope is removed from the guide, and the milling bar or high-speed air turbine is inserted in its place. The milling bar is used for slow-speed drilling of the hole. Two standard milling cutters are supplied: 0.062 and 0.125in (1.6 and 3.2mm) diameter. The milling bar is equipped with a universal joint for flexible connection to a drill motor.



Conventional slow-speed milling may be satisfactory on some mild steels and aluminum alloys. But high-speed drilling is generally the most convenient and practical method for introducing the hole in all test materials. (When residual stresses are to be measured on materials such as stainless steels, nickel-based alloys, etc., ultrahigh-speed drilling techniques are preferred.) For this purpose, a high-speed air-turbine assembly, along with a supply of tungsten carbide-tipped cutters [ten each 0.031in (0.8mm) diameter and 0.062in (1.6mm) diameter], is supplied with the milling guide. A foot pedal control is included for operating the air turbine.



A micrometer depth set attachment, available in English or metric units, is provided with each milling guide assembly. This device is used for incremental drilling when information on the variation of residual-stress-with-depth is desired.

Other items supplied include a plastic template for the proper location of the milling guide foot pads on the test part and a special break-off tool used to remove the foot pads from the part after the test is completed. All components are housed in a sturdy carrying case. The guide is approximately 9in (230mm) high, and 4.5in (114mm) wide at the base.

A fast-setting-cement kit, used to firmly attach the guide to the test part, is available as an accessory item.

VISHAY MEASUREMENTS GROUP

Vishay Micro-Measurements
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Vishay Systems

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One of the World's Largest Manufacturers
of Discrete Semiconductors and Passive Components

STRAIN GAGE INSTRUMENTATION

DATA BOOK

VISHAY

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United States

One of the World's Largest
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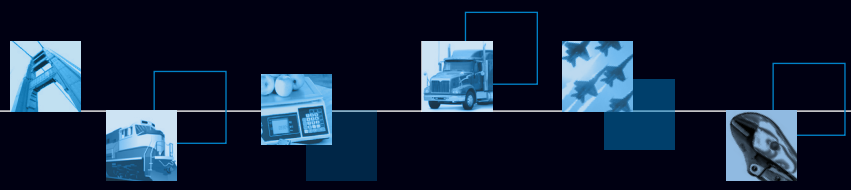
of Discrete Semiconductors and Passive Components



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